UNIVERSITY OF PENNSYLVANIA

CHANGES IN ACHIEVEMENT FOLLOWING THE REMOVAL OF CERTAIN PHYSICAL DEFECTS IN ELEMENTARY SCHOOL PUPILS

RAYMOND L. CHAMBERS

A THESIS

IN EDUCATION

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

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CHAPTER I

Development of School Interest in the Physical Welfare of the Child

Within the period of recorded history, astounding changes have occurred in the attitude of man towards his physical being and his appreciation of human values. The Athenian ideal of physical perfection is in sharp contrast to the ascetic contempt and abuse of the human body. A wide gulf exists between the practices of ancient Sparta and present-day attitudes towards the physical defective. In ancient Sparta, for example, a new-born child was inspected by the heads of the tribe. If it was judged unhealthy or weak, it was exposed to die on the wild slopes of Mt. Taygetos. Today, in progressive school systems, the crippled, blind, and deaf are trained to make the most of their lives in the world in which they find themselves so greatly handicapped.

A. European Beginnings of School Health Work:

In developing the history of health work in the schools, Gulick and Ayres[1], Newmayer[2], Wood and Rowell[3], and Keene[4] show that the "medical inspection" of schools had its initial development in Europe.

The first health interests of the schools were directed toward sanitation and the control of communicable diseases. France, in 1833, by royal decree, was the first nation to make the educational authorities responsible for the sanitary conditions of school premises and the health of school children. In actual practice, however, it was not until 1879 that France[5] had a system of genuine medical inspection. Brussels, Belgium,[6] is credited with the establishment of the first system of medical inspection in the

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[1] Luther H. Gulick and Leonard P. Ayres, *Medical Inspection of Schools* New York, Russell Sage Foundation, 1913, pp. 7 ff.

[2] S. W. Newmayer, *Medical and Sanitary Inspection of Schools*, Phila., Pa., Lea and Febiger, 1924, pp. 19 ff.

[3] Thomas D. Wood and Hugh Grant Rowell, *Health Supervision and Medical Inspection of Schools*, Phila., Pa., W. B. Saunders Co., 1927, pp. 17 ff.

[4] Charles H. Keene, *The Physical Welfare of the School Child*, New York, Houghton, Mifflin Co., 1929, pp. 81 ff.

[5] Luther H. Gulick and Leonard P. Ayres, *Op. cit.*, p. 7.

[6] Thomas D. Wood and Hugh Grant Rowell, *Op. cit.*, p. 18.

fuller sense of the term. In 1874, school physicians were appointed in Brussels and required to inspect every school three times a month. Weisbaden, Germany,[7] is credited with an important advance in medical inspection work. Health work in the German States began as early as 1867 with vision tests in the Dresden schools, but it was not until 1889 that Weisbaden developed a system of careful and thorough medical examination. In Weisbaden, pupils were examined at the time of entrance to school, and the examination was repeated in the second, fourth, sixth, and eighth school years. The heart, lungs, throat, spine, skin, and higher sense organs were examined. Records were kept and parents were notified of the results of the examinations.

B. Development of School Health Work in America:

In America, as in Europe, the first health work in the public schools was concerned with the control of communicable diseases. A series of diphtheria epidemics among Boston school children, in 1894,[8] led to the appointment of fifty physicians to care for the medical inspection districts that were created in efforts to suppress this disease. Other cities soon followed. Chicago introduced "medical inspection" in 1895, New York City in 1897, and Philadelphia in 1898. The first school nurses were appointed in New York City in 1902, and, in 1905, the medical inspectors in that city began complete physical examinations of all school children.[9]

Not long after medical inspection was introduced into some of the larger city school systems, State Legislatures[10] began to take an interest in this form of public health work. Connecticut is credited with the first state medical inspection law, when, in 1899, teachers were required to test the eyesight of each pupil every three years. Vermont followed, in 1904, by requiring eye, ear, and throat examinations. Massachusetts made vision and hearing tests mandatory in the Statutes of 1906. By 1929, a total of thirty-eight states had statutes or regulations relating to the

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[7] Luther H. Gulick and Leonard P. Ayres, *Op. cit.*, p. 9.
[8] Charles H. Keene, *Op. cit.*, p. 84.
[9] S. W. Newmayer, *Op. cit.*, p. 21.
[10] Thomas D. Wood and Hugh Grant Rowell, *Op. cit.*, p. 19.

examination of children for physical defects. In twenty-four of these states, the law is more or less mandatory in its wording for all school districts.[11]

School health work, within comparatively recent years, has enlarged the scope of its activities and earnest efforts have been made to increase the effectiveness of its methods. The World War did much to stimulate these changes. The physical examination of the young men who were called to the colors in 1917 and 1918 revealed an astounding percentage of defects of many kinds. Reports of the Surgeon-General of the United States Army[12] show that nearly half of the men examined had one or more physical defects. More than half a million (24.96 per cent) were rejected or exempted from military service because of defects of severe degree.

Alarmed by such conditions among the youth of the nation, educators began a critical review of school health materials, methods, and practices.[13] Courses of Study were revised. Emphasis was laid upon "doing", rather than "knowing". The scope of health service was greatly enlarged. The old terms and expressions no longer seemed adequate to express fully enough the newer and enlarged concepts of health work in the schools. The curriculum subject known as "Physiology and Hygiene," under which the major portion of the health teaching had been carried on for years, gave way to "Health Education". "Medical Inspection" became part of a larger and more varied "Health Service and Supervision". As a name for this whole field of activity, the Health Section of the World Federation of Education Associations, at Toronto, 1927,[14] recommended that the phrase

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[11] James F. Rogers, *State Wide Trends in School Hygiene and Physical Education as Indicated by Laws, Regulations and Courses of Study*, Office of Education Pamphlet No. 5, Washington, D. C., U. S. Dept. of the Interior, p. 3.

[12] *Defects Found in Drafted Men*, United States Surgeon-General's Office, Washington, D. C., U. S. War Department, 1920, p. 73.

[13] Charles H. Keene, *Op. cit.* pp. 6–8, 20.

Jessie F. Williams, *Hygiene and Sanitation*, Phila., Pa., W. B. Saunders Co. 1927, p. 37.

Lewis M. Terman and John C. Almack, *The Hygiene of the School Child*, New York, Houghton, Mifflin Co., 1929, p. 3.

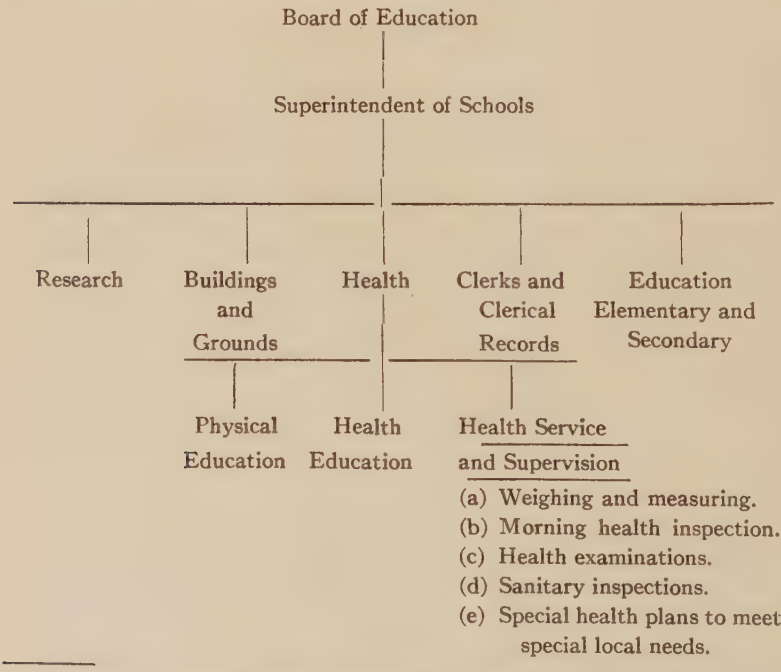
[14] *Proceedings, Second Biennial Conference*, Toronto, Canada, World Federation of Education Associations, 1927, p. 453.

SCHOOL HEALTH PROGRAM be used to describe all health activities, including the teaching of health and the various forms of school health services.

Thus, it is found, in the words of W. H. Howe, President of the American Association of School Physicians, that:

"from its initial single purpose, the control of diphtheria, school health service, in thirty-four years in this country has so broadened and extended its purpose that, today, when best organized and most efficiently administered, it seeks to deal with the whole child as a health unit and with his environmental influences in school."[15]

Diagrammatically, the place of health service and supervision is placed by Wood and Rowell[16] as follows:



[15] William A. Howe, *Medical Leadership in School Medical Inspection and Health Service.* Paper read before section on Public Health and Hygiene, 78th Annual Meeting of the Illinois State Medical Society, Chicago, Reprint, *Illinois Medical Journal*, July, 1929, p. 2.

[16] Thomas D. Wood and Hugh Grant Rowell, *Op. cit.*, p. 33.

CHAPTER II

Some Relationships Between Physical Defects and Health, Intelligence, and School Achievement

On the physical side, health is that condition of the body in which each part works in harmony with every other part. Modern conceptions[1] of health set up the ideal of health as a quality of life which enables the individual to live most and serve best.

Health is influenced in varying degrees by heredity, environment, and personal factors.[2] Heredity contributes to innate strength and vigor. It likewise contributes to disease, for there are racial differences in susceptibility to certain diseases. Environmental factors that make a positive contribution to health include clean, sanitary homes and factories, pure food and water supplies, and ample recreational facilities. Unhygienic living conditions, on the contrary, are detrimental to health. Upon the individual, however, often falls the responsibility for the degree of realization of the health ideal. Through proper habits of living, and intelligent use of modern methods of disease prevention, the individual may overcome some of the hereditary and environmental handicaps. On the other hand, benefits due to favorable heredity, or environmental conditions, may be lost to the individual through careless, ignorant, or wilful abuse of the fundamentals of healthy living.

Diseases vary in the way they attack the body. Infectious diseases, such as diphtheria, typhoid fever, pneumonia, attack rather suddenly. Others, including forms of heart trouble, kidney affections, and tuberculosis, are more insidious in the manner of their development. Serious impairment, or destruction of tissues, often occurs before the individual becomes aware of the presence of a serious potential disabling condition. One of

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[1] Thomas D. Wood and Others, *Health Education, A Program for Public Schools and Teacher Training Institutions.* Report of Joint Committee on Health Problems in Education of the National Education Association and the American Medical Association. New York, 1924, p. 11.
Jessie F. Williams, *Op. cit.*, p. 33.

[2] Jessie F. Williams, *Op. cit.*, pp. 42–45.

the most helpful features in this situation, however, is that by means of periodic physical examinations, some of these harmful conditions,

"can be checked by changes in manner of living, correction of minor defects in teeth and tonsils, and alteration of habits."[3]

The physical, or health examination as concisely stated by Newmayer, is:

"for the purpose of detecting any variation from the normal that may interfere with the health, growth, and development of the child."[4]

Evidence that such variations from the normal are abundant among school children of today is readily found in the annual reports of school health officials. In Philadelphia, Pa., for example, the report for the year ending June 30, 1929, shows a total of 315,363 defects found in 261,344 examinations.[5]

A. Physical Defects as Actual or Potential Handicaps:

A number of relationships have been discovered between physical defects and health, intelligence, and school achievement. Defective teeth, for example, may exert a detrimental effect upon the health of the whole body in a number of ways,[6] including interference with proper mastication of food, toxic effect of pus, reflex nervous disturbances due to pain, and possible breeding-grounds and foci for the distribution of the germs of a number of infectious diseases.[7]

Any considerable degree of hyperopia, or farsight, uncorrected by glasses, is a source of constant eye strain. In cases of uncorrected myopia, or nearsight, distant objects are not clearly seen, thus handicapping the myope in many ways.[8] Excessive use

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[3] Jessie F. Williams, *Op. cit.*, p. 82.
[4] S. L. Newmayer, *Op. cit.*, p. 73.
[5] See p. 45 for itemized list of defects.
[6] Lewis M. Terman and John C. Almack, *Op. cit.*, p. 174.
[7] Frederick B. Moorehead and Kaethe W. Dewey, *Pathology of the Mouth*, Phila., Pa., W. B. Saunders Co., 1925, p. 71.
[8] George E. DeSchweinitz, *Diseases of the Eye, 10th Edition*, Phila., Pa., W. B. Saunders Co., 1924, pp. 141–142.

of accommodation in astigmatism always finally results in eye strain.[9]

The germs of a number of diseases find their way into the body through the nose and mouth. The tonsils and adenoids are believed[10] to be of assistance in protecting the body against the invasion of germs through the nose and mouth. When tonsils become diseased, however, they lose their ability to protect, and actually harbor dangerous germs and toxins. The harmful effects of infectious inflammation of the tonsils, according to Greene,

"Comprise recurring acute inflammation of the nose and throat with secondary inflammation of the middle ear, and sometimes, nasal sinuses; infections of the glands of the neck, and more remote, secondary inflammations in the joints and in the heart, which are the result of infection carried by the blood stream from infected tonsils."[11]

Halsey found a history of tonsillitis in nearly 70 per cent of children with heart disease. Tonsillitis, he therefore concludes,

"should be considered a potentially serious disease in children."[12]

Children with physical defects have been found to be absent from school on account of sickness more than children with no defects.[13] Cornell,[14] in 1908, found that only 28.8 per cent of a group of *exempt*[15] pupils had one or more physical defects, whereas,

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[9] Lewis M. Terman and John C. Almack, *Op. cit.*, p. 259.
[10] Lewis M. Terman and John C. Almack, *Ibid.*, p. 197.
[11] D. Crosby Greene, "Tonsils and Adnoids in Children," *Journal of Educational Research*, Vol. 60 (1922) p. 666.
[12] Robert H. Halsey, "Early Recognition and Proper Care of Heart Diseases Among School Children," *Journal of the National Education Association*, Volume 60 (1922) p. 671.
[13] Selwyn D. Collins, "Relation of Physical Defects to Mental Defects in School Children," *Public Health Report, United States Public Health Service*, Vol. 37, No. 36 (Sept. 8, 1922) p. 2186.
[14] Walter S. Cornell, "The Relation of Physical to Mental Defects in School Children," *Psychological Clinic*, Vol. 1 (Jan. 15, 1908) pp. 231–234.
[15] Exempt pupils were those, who, by reason of meritorious work throughout the year, were advanced to the next higher grade without examination. The non-exempt pupils were required to pass examinations in a number of different subjects in order to qualify for promotion.

38.1 per cent of the *non-exempt* pupils were found physically defective.

A more recent study,[16] utilizing standard intelligence and achievement tests, found that there was a tendency for the children in the better physical condition to have higher ratings in intelligence and educational achievement.

An investigation in this field by Mallory[17] showed that certain physical defects were associated with low scores in school achievement. The relationships between the presence or absence of physical defects and school achievement in this study were obtained from a study of 515, grade 1–8 pupils in Humboldt, Tennessee. The nurse's examination of the pupils disclosed 69 cases of "eye" and "vision" defects, 139 "tonsil" defects, 37 "nasal obstruction", 195 "dental caries", and 23 "hearing" defects. 184 pupils were found to have been without any recorded defects. A wide range of tests was given to measure achievement, including tests in arithmetic, spelling, reading, English, handwriting, and geography. Intelligence was measured by the Illinois intelligence test. In order to combine scores, each individual score was reduced to the per cent of the median for the class. Pearson's method "for determining correlation between a measured character 'A' and a character 'B', of which only the percentage of cases wherein B exceeds a given intensity, is recorded for each grade of 'A',"[18] was used for determining the relationship between the presence or absence of the physical defects and school achievement. Summarized results of Mallory's study are given in Table 1, p. 17. Positive coefficients of correlation in Table 1 indicate that the defective groups tended to make lower achievement scores than the non-defective groups.

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[16] Carolyn Hoefer and Mattie C. Hardy, "The Influence of Improvement in Physical Condition on Intelligence and Educational Achievement," *Twenty-Seventh Yearbook of the National Society for the Study of Education, Part I.* Bloomington, Ill., Public School Publishing Co., 1928, pp. 321–387.

[17] James N. Mallory, *A Study of the Relations of Some Physical Defects to Achievement in the Elementary School*, Nashville, Tenn., Geo. Peabody College for Teachers, 1922, Doctorate Thesis, pp. 70–72.

[18] James N. Mallory, *Ibid.*, p. 36.

TABLE 1

RELATION OF SPECIFIC DEFECTS TO ACHIEVEMENT SCORES AFTER MALLORY[17]

	ORIGINAL Q (COEFFICIENT OF CORRELATION) WITH PROBABLE ERRORS	COEFFICIENT OF CORRELATION FREED FROM INFLUENCE OF INTELLIGENCE
Eyes and Vision	.03 ± .044	.01
Tonsils	.14 ± .044	.12
Nasal Obstruction	.80 ± .016	.81
Teeth	.30 ± .02	.29

The relationships between the presence or absence of physical defects and achievement in arithmetic and reading for the pupils of the present study have been determined, and the results presented in Table 15, Chapter IV, page 61. It will be noted from these results, that, while defective vision and diseased tonsils were slightly associated with low scores in achievement in arithmetic and reading, it is unlikely that there was a marked negative association between these factors. Furthermore, in the light of the probable errors of the coefficients of correlation obtained, the probability is slight that there was a definite negative relationship between dental caries and nasal obstruction, and achievement in arithmetic and reading, as measured by the tests used in this study.

It will be noted, therefore, that the relationships found in the present study between defective vision and diseased tonsils and achievement correspond more closely with these found by Mallory than do those obtained for nasal obstruction and dental caries.

B. CORRECTION OF PHYSICAL DEFECTS:

In addition to daily inspection and periodic health examinations, school health service includes the correction of remediable physical defects as an important part of its work. This corrective work[19] embraces services such as the fitting of glasses for defective

[19] Thomas D. Wood and Hugh Grant Rowell, *Op. cit.*, p. 35.

vision, the removal of diseased tonsils and adenoids, and dental prophylaxis and treatment. The methods used for securing corrections are persuasive, rather than compulsory. More corrections can be obtained where there is a unified cooperation of all concerned. The school physician should be supplemented by the school nurse. The school nurse is able to establish a closer contact with the home, has opportunity further to interpret the examination record to pupil and parent, and often can secure the aid of public and private agencies in obtaining the corrections. The teacher's influence is also very important. She should be conscious of her responsibilities in this phase of school health service, encouraging, supplying needed health instruction, and stimulating the development of proper habits of living.

Improvements in physical condition and general health after the removal of certain physical defects, have been frequently noted. Clark and Bell[20] report significant increases in weight following the removal of such defects as diseased tonsils, adenoids, defective teeth, and defective vision.

The increased prevalence of neuralgia, headache, nervousness, and colds among industrial employees with dental defects, over those without dental defects, caused Hyatt[21] to conclude that dental corrections are important factors in all health work. Properly prescribed and fitted glasses are important aids to the improvement of defective vision and relief of headache from eye strain and eye defects.

From a ten-year study of tonsillectomized children in Rochester, N. Y., Kaiser found that the results of the removal of the tonsils were evident:

"in the reduction of sore throat, cervical adenitis, otitis media, scarlet fever diphtheria, rheumatic fever, and heart disease."[22]

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[20] Taliaferro Clark and Elizabeth Bell, "Correcting Physical Defects in School Children," *Public Health Report, United States Public Health Service*, Vol. 37, No. 16 (April 21, 1922) p. 940.

[21] Thaddeus P. Hyatt, "Dental Work as a Prophylactic Measure," *American Journal of Public Health*, Vol. 12 (April 1922) p. 327.

[22] Albert D. Kaiser, "Results of Tonsillectomy, a Comparative Study of Twenty-two Hundred Tonsillectomized Children with an Equal Number of Controls Three and Ten Years after Operation," *Journal of the American Medical Association*, Volume 95 (Sept. 20, 1930) p. 840.

With regard to the removal of enlarged adenoids, Jackson and Coates state that:

"the results following the removal of adenoids are always so favorable that no hesitation should be had in recommending an operation if they are at all enlarged and if there is any retraction of the tympanic membranes. The beneficial effects of the operation on mouth breathing are often immediate, and normal respiration is restored. The effect upon hearing is usually noticed at once. The voice loses its dead, toneless character, and if there are no other causes for nasal obstruction, ill health, and stupidity, the children are in a short time, perfectly well."[23]

Evidence concerning changes in intelligence and school achievement following the removal of physical defects is relatively scarce.

Hoefer and Hardy's[24] study covered a three-year period and embraced 343 third and fourth grade children of Joliet, Illinois, public schools. In this study, the measure of school accomplishment was the Stanford Achievement Examination, Form A, primary and advanced examinations. Intelligence was measured by the Stanford Revision of the Binet-Simon Intelligence Test. The four criteria used for physical improvement were as follows:

1. The general physical conditions, as based upon the judgment of the physician.
2. The condition of the tonsils.
3. Three physical tests, namely, strength of grip, as an index of general muscular conditions, breadth of shoulders, as indicative to some degree of a child's robustness, and an increase in weight in proportion to age, as a rough index of nutritional status.
4. The habit of drinking coffee.

The judgment of the physician regarding the physical condition of a child was based on the degree to which specific defects had a detrimental effect upon his general condition at the time of the examination, and was designated as good, fair, poor. These children were divided into four groups on the basis of their condi-

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[23] Chevalier Jackson and George Morrison Coates, *Nose, Throat, and Ear*, Phila., Pa., W. B. Saunders Co., 1929, pp. 350–351.

[24] Carolyn Hoefer and Mattie C. Hardy, *Op. cit.*, pp. 371–387.

tion at the time of the first and last examinations in order to show improvement, or lack of it. These groups were called:

Group I—"Good," including pupils in good physical condition at the first and last examinations.

Group II—"Improved," including pupils in fair physical condition at the first examination and good at the last, or poor condition at the first examination, and fair or good at the last.

Group III—"Poorer", including pupils in good physical condition at the first examination, and fair or poor at the last, or fair condition at the first and poor at the last.

Group IV—"Fair or Poor", including pupils in fair physical condition at the first examination and fair at the last, or poor at the first and poor at the last.

The results were presented in terms of monthly rate of improvement in arithmetic, reading, and spelling. No consistent changes in achievement were found in the groups that were classified on the basis of general physical condition. The "good" and "improved" groups had the highest rate in reading and spelling, while the "poorer" and "fair" groups had the highest in arithmetic. The only differences found significant, however, were those in spelling, so it is therefore concluded for this study, that:

"the improved physical condition of these children may be an effective factor in progress in dictation (spelling), but there is no indication that it is influential in reading or arithmetical achievement."[25]

The authors, realizing that their method of judging physical conditions was partly subjective, made an additional study of a specific defect, the condition of the tonsils. For purposes of comparison, the condition of the tonsils was subdivided into five classes, as follows:

1. Tonsils removed prior to the beginning of the experiment, 1923.
2. Tonsils removed during the experiment.
3. Tonsils in normal condition.

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[25] Carolyn Hoefer and Mattie C. Hardy, *Ibid.*, p. 379.

4. Tonsils showing definite improvement.
5. Diseased condition of the tonsils.

As a result of this part of the study, it was concluded that:

"no evidence is apparent that the good or bad condition of tonsils had any effect on intelligence, but those children who showed improvement in condition of tonsils had the highest rate in school achievement."[26]

C. Statement of Problem of Thesis:

The problem of this thesis is the determination of changes in achievement following the removal of certain physical defects in elementary school pupils. It is partly the outgrowth of Cornell's[27] statement of the need for a study based upon the comparison of scholarship before and after the correction of certain physical defects. This study has been extended considerably beyond that of Hoefer and Hardy to include the following physical defects:

1. Dental caries (1–3 defective teeth) without other defects.
2. Dental caries (4 or more defective teeth) without other defects.
3. Defective vision, $\frac{15}{30}$, or less with or without dental caries only.
4. Diseased tonsils, with or without dental caries only.
5. Nasal obstruction, and diseased tonsils, with or without dental caries only.

The records of the school medical examiners and school nurses enabled the division of the pupils into three groups, as follows:

1. A corrected group for each physical defect.
2. An uncorrected group for each physical defect.
3. A no-defect group.

The measures of achievement were obtained from tests in arithmetic (fundamental operations), reading comprehension, and spelling. Raw scores in all initial and subsequent tests have been translated into standard scores in order to make them comparable, and to enable combining the scores of two or more tests.

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[26] Carolyn Hoefer and Mattie C. Hardy, *Ibid.*, p. 387.
[27] Walter S. Cornell, *Health and Medical Supervision of School Children*, Phila., Pa., F. A. Davis Co., 1912, p. 224.

Changes in achievement in arithmetic, reading, and spelling following the correction of physical defects were determined and evaluated as follows:

1. By differences between mean standard scores of initial and subsequent achievement tests.
2. By coefficients of partial correlation between the correction or non-correction of a physical defect and gains or losses in achievement in arithmetic, reading, and spelling, with the influence of age and intelligence partialed out.

Because of the multiplicity of factors[28] that influence such a complex product as school proficiency, cause and effect relationships between the removal of physical defects and gains or losses in school achievement have not been attempted. Within the limits of the study, however, and with the control of certain factors, and an accounting for others, it is believed that the results will add somewhat to the sum total of what apparently is a rather meagre scientific knowledge concerning changes in achievement in such school subjects as arithmetic, reading, and spelling, following the removal of certain physical defects in elementary school pupils.

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[28] See pages 53–55.

CHAPTER III

Collection and Treatment of Data

A. Selection of Schools and Grades:

The pupils chosen as subjects for this study were enrolled at the time of the routine medical examination in Grades 3, 4, and 5, in six Philadelphia, Pennsylvania, public schools.* Five of the schools, A, B, D, E, and F respectively, formed an *ability-grouping* unit within the Philadelphia school system, thereby making available certain necessary objective test records of intelligence and achievement that were not obtainable in schools not similarly grouped. School C was likewise organized upon an ability-group basis, having formerly been a part of a larger group of schools for the study of this problem.

A brief review of the ability-grouping movement in Philadelphia will be of value in calling attention to a number of similarities in the organization and administration of the selected schools. Philadelphia, in 1922, began an experiment[1] in grouping pupils on the basis of abilities, with a view toward improving the effectiveness of instruction. By September, 1925, there were forty-two elementary schools in which pupils were grouped by ability in at least some of the grades. In June, 1926, the Division of Research of the Philadelphia Public Schools began a survey of the relative successes of pupils in *grouped* and *ungrouped* organizations. For further intensive study, five elementary schools (Schools A, B, D, E, F, of this study) were selected to provide a restricted, intensive field of research. The principals of these five schools, together with the superintendents of the districts in which the selected schools were located, the Director of the Division of Research, and an Associate Superintendent, formed a committee to further this work. As a result, a more uniform technique of supervision and administration, a more elaborate testing

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* The names of these schools are filed with the Graduate School of the University of Pennsylvania, Philadelphia, Pa.

[1] Philip A. Boyer, "The Philadelphia Experiment in Homogeneous Grouping," *Schoolmen's Week Proceedings*, Volume XVII (1930)—Phila., Pa., University of Pennsylvania, pp. 241 ff.

program, and a personnel with greater experience in the technique of testing and measuring have developed within these schools than would otherwise have been the case. School C, by reason of retention of ability-grouping and personal interest of the principal, the author of this study, in the progress of the ability-grouping experiment, has paralleled the work of these other schools in all essential respects.

Boyer cites a number of general principles which have been formulated for the organization and administration of the work in these ability-grouped schools as follows:

1. "Classification into ability groups is based primarily upon the results of individual and group intelligence tests administered at the time of entrance to school, and subsequently during the second and fourth school years.
2. "Ability groups are uniformly designated as Groups I, II, III.
3. "Transfers from group to group are made after the acquisition of additional information relative to capacities, interests, and needs of the pupils.
4. "Teacher assignments are made so as to secure concentration upon the teaching of one ability group for an entire school year.
5. "Curriculum adjustments, in the main, are made on the bases of enrichment and limitation rather than that of rate of progress.
6. "Objective tests are administered in all ability-grouped schools at the beginning and end of each semester. The results of these tests are interpreted in terms of percentile position in the city distribution of scores, and these are posted for each pupil on an individual achievement record card devised for the purpose."[2]

The Philadelphia School System is organized upon a 6–3–3 basis. The fifth grade, therefore, was chosen as the upper grade limit for this study so that a majority of the pupils would likely be in the same school at the final testing period, a year or so after the initial tests. The third grade was taken as the lower grade

[2] Philip A. Boyer, *Ibid.*, pp. 243–244.

TABLE 2

Enrollment

Number of Classes and Pupil Enrollment, September, 1929, in Selected Schools and Grades

Grade	School A		School B		School C		School D		School E		School F		Total schools A–F (inc.)	
	No. of classes	No. of pupils	No. of classes	No. of pupils	No. of classes	No. of pupils	No. of classes	No. of pupils	No. of classes	No. of pupils	No. of classes	No. of pupils	No. of classes	No. of pupils
1.....	6	289	7	295	6	278	5	250	6	235	5	250	35	1,597
2.....	6	245	5	245	6	226	4	165	5	244	5	205	31	1,330
3.....	7	284	5	213	6	240	6	248	5	216	6	236	35	1,437
4.....	5	236	6	266	5	220	5	202	5	207	6	203	32	1,334
5.....	5	201	5	218	5	215	5	204	5	195	5	163	30	1,196
6.....	5	246	6	227	6	234	5	199	6	214	6	267	34	1,387
Total all Grades.	34	1,501	34	1,464	34	1,413	30	1,268	32	1,311	33	1,324	197	8,281
Total Grades, 3, 4, 5.	17	721	16	697	16	675	16	654	15	618	17	602	97	3,967

limit, largely because of the scarcity of objective test results in school achievement in the first and second grades.

Tables 2 to 6 present comparative data regarding the enrollment, race, nationality, age, and intelligence of the pupils in the selected schools and grades.

The total enrollment of the selected schools, table 2, was found to be fairly uniform in regard to the number of classes and pupils enrolled in September, 1929, when the routine medical examinations were begun. The presence of several classes within each grade was likewise favorable to ability-grouping.

TABLE 3

RACE

PUPILS IN SELECTED SCHOOLS AND GRADES

	NUMBER OF PUPILS						
	SCHOOL A	SCHOOL B	SCHOOL C	SCHOOL D	SCHOOL E	SCHOOL F	SCHOOLS A-F INC.
White...	566	521	601	395	583	575	3241
Negro...	6	5	7	73	2	0	93
*Totals..	572	526	608	468	585	575	3334

* The totals in this and subsequent tables include only pupils who were enrolled in the same schools at both the initial and final testing periods. School D is the only one of the selected schools that enrolled any considerable percentage of negro pupils. There were none enrolled in School F. Because of these inequalities in representation among the schools and certain racial differences relating to health and disease, the negro pupils were eliminated from the study. Results, therefore, are based upon records of white pupils only.

Table 4 shows that the nationality of the pupils, according to the birthplace of the father, varied in some respects from the city averages, with a tendency toward a larger proportion of foreign-born fathers than for the city as a whole.

Some variations from city median ages were found among the different schools and grades. The general tendency was toward a group of pupils in the selected schools and grades slightly younger than the city grade-medians.[3] This might be expected within a

[3] Philip A. Boyer, *Age-Grade-Survey*, Division of Educational Research, Phila., Pa., Board of Public Education, Bulletin No. 146, (February, 1930), p. 45.

TABLE 4

Nationality

Birthplace of Fathers of Pupils in Selected Schools and Grades, and City Totals

Country	School A		School B		School C		School D		School E		School F		Total Schools A-F		Totals City[2] 1929
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	%
United States..	472	83.3	231	44.3	86	14.3	92	23.3	370	63.5	144	25.1	1395	43.0	57.7
Russia.....	26	4.6	198	38.0	309	51.4	35	8.9	45	7.7	28	4.9	641	19.8	10.1
Ireland.....	3	0.5			1	0.2			9	1.5			13	0.4	3.5
Italy.....	21	3.9	38	7.3	180	30.0	256	64.8	21	3.6	22	3.8	538	16.6	13.9
Germany.....	6	1.0	2	0.4	3	0.5			55	9.4	8	1.4	74	2.3	1.9
Poland.....	1	0.2	2	0.4			2	0.5	2	0.3	294	51.1	301	9.3	5.1
England.....	15	2.6	7	1.3	3	0.5	3	0.8	15	2.7	2	0.3	45	1.4	1.3
Hungary.....	1	0.2	1	0.2	1	0.2			6	1.0	1	0.2	10	0.3	0.9
Miscellaneous..	21	3.7	42	8.1	18	2.9	7	1.7	60	10.3	76	13.2	224	6.9	5.6
Totals.....	566	100.0	521	100.0	601	100.0	395	100.0	583	100.0	575	100.0	3241	100.0	100.0

[2] Report, Bureau of Compulsory Education, Board of Public Education, School District of Philadelphia, for Year Ending June 30, 1929, p. 90.

TABLE 5

AGE

MEDIAN AGES OF PUPILS IN SELECTED SCHOOLS AND GRADES, AND CITY MEDIANS

GRADE	MEDIAN AGE—YEARS—MONTHS							
	SCHOOL A	SCHOOL B	SCHOOL C	SCHOOL D	SCHOOL E	SCHOOL F	TOTAL SCHOOLS A-F INC.	CITY MEDIANS[4]
3.....	8.6	8.5	8.7	8.6	8.9	8.11	8.7	8.8
4.....	9.7	9.4	9.6	9.8	9.7	9.11	9.7	9.8
5.....	10.10	10.7	10.7	10.10	10.7	11.3	10.9	10.11

STANDARD AGE AND MEDIAN AGE BY GRADES (1–12)
(PHILADELPHIA, PA., SEPTEMBER, 1929)

	GRADES											
	1	2	3	4	5	6	7	8	9	10	11	12
Standard Age....	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5
Median Age....	6.5	7.7	8.8	9.8	10.11	11.11	12.11	13.8	14.7	15.4	16.4	17.2

group of schools organized on an ability basis in order to adapt methods and materials to the individual. Higher promotion rates in the ability-grouped schools than for the city as a whole have been maintained for a number of years.[5] This tends to reduce overageness in these schools.

TABLE 6

INTELLIGENCE

INTELLIGENCE QUOTIENTS OF PUPILS IN SELECTED SCHOOLS AND GRADES

	INTELLIGENCE QUOTIENTS						
	SCHOOL A	SCHOOL B	SCHOOL C	SCHOOL D	SCHOOL E	SCHOOL F	TOTAL SCHOOLS A-F INC.
Median.....	98.97	96.28	93.15	93.35	99.18	92.08	95.62
Standard Deviation.....	14.20	13.44	12.09	12.07	14.80	11.30	13.35

[4] Philip A. Boyer, *Ibid.*, p. 45.

[5] Philip A. Boyer, "The Philadelphia Experiment in Homogeneous Grouping," *Schoolmen's Week Proceedings*, Volume XVII (1930) Phila., Pa., University of Pennsylvania, p. 249.

Mean intelligence quotients were not available for the city as a whole. The mean I. Q. for the entire group of selected schools and grades was sufficiently high, however, to characterize the group as being of average intelligence, as measured by the Otis Classification Test.

B. Collection of Data:

The multiplicity of descriptive items and examination results needed for the study necessitated the preparation of a large data sheet for their collection and recording. Details of this sheet will be found on pages 124 to 131. One hundred sheets were used, one for each of the separate grade-sections included in the study. Wherever possible, the data were grouped and recorded in the order of their appearance upon the forms from which they were obtained.

1. *Identification and Descriptive Data*:

Information concerning a pupil's name, grade, room number, race, date of birth, and country of birth of child and father, was obtained from the pupil's registration card. This card form is made out at the time of a child's entrance to school, and follows the pupil throughout his school career. It is an important official record, from which many others are made from time to time, as needed. Ages were calculated from the date of birth to the nearest half year by means of the Baltimore Age Calculator.[6] Permission was obtained from the Department of Superintendence of the City of Philadelphia to visit the selected schools at suitable times in order to obtain the records that were needed. This information was personally obtained by the writer from the pupils' registration cards with such assistance as needed, during the fall of 1929. Personal checks were made by the writer in order to insure the accuracy of the recording.

2. *Intelligence Records*:

As stated earlier in the chapter, standard group intelligence tests are regularly administered in the ability-grouped schools in

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[6] John L. Stenquist, *Baltimore Age Calculator*, Yonkers, N. Y., World Book Co.

the second and fourth grades. The Haggerty Intelligence Examination, Delta 1 is used in the second grade and the Otis Classification Test in the fourth grade. The intelligence quotients obtained from these tests are recorded in the ability-grouped schools on the pupil's Achievement Record Card. Intelligence quotients for all pupils in schools A, B, D, E, F, were obtained personally by the writer from these Achievement Record Cards. In School C, intelligence quotients were obtained directly from tests administered by the principal of the school at the time of the initial testing period. The inability to give special tests to the pupils used in this study required the use of intelligence quotients obtained from two different tests administered at times varying from a few weeks up to one and one-half years prior to the initial achievement tests. By the use of statistical procedures similar to those suggested for this purpose by Woodworth[7] and Kefauver,[8] the intelligence quotients obtained from the Haggerty and Otis Tests were equated. These procedures are described in detail later in this chapter, pages 47–48.

A number of studies[9] involving re-tests of the intelligence of the same individuals after varying intervals ranging from a few days up to several years have given results which have warranted a conclusion that the I. Q. remains relatively constant, at least, throughout the elementary school years. Re-tests to 315 children in the vicinity of Stanford University caused Terman to conclude:

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[7] R. S. Woodworth, "Combining the Results of Several Tests," *Psychological Review*, Vol. XIX (March, 1912) pp. 97–123.

[8] Grayson N. Kefeuver, "Need of Equating Intelligence Quotients Obtained from Group Tests," *Journal of Educational Research*, Vol. 19 (Feb. 1929) p. 92.

[9] Lewis M. Terman, *The Intelligence of School Children*, New York, Houghton Mifflin Co., 1929, pp. 38 ff.

Lewis M. Terman, "Reply to Criticisms of Part I, Twenty-seventh Yearbook of the National Society for the Study of Education," *Journal of Educational Psychology*, Volume 19 (Sept. 1928), pp. 370 ff.

Cecile Colloton and Harold O. Rugg, "Constancy of the Stanford-Binet I.Q.'s as shown by Re-tests," *Journal of Educational Pyschology*, Vol. 12, (May, 1921), pp. 315–322.

L. S. Rugg, "Re-tests and the Constancy of the I.Q.," *Journal of Educational Psychology*, Vol. 17 (May, 1925), pp. 341–343.

"that it makes little difference whether the child was bright, average or dull, how long an interval separated the tests, or what the age of the child was at the earlier test. The majority of changes for all groups was small."[10]

Terman further concludes:

"that it makes little difference whether the successive tests are separated by an interval of a few months or several years. The central tendency of change and the proportion of changes included in a given range remain much the same."[11]

Colloton and Rugg reviewed a number of studies concerned with re-tests of intelligence, and report that:

"new investigations tend to confirm Terman in his 1917 conclusions and give us much confidence in the constancy of the I. Q. as measured by the Stanford Revision of the Binet-Simon Scale."[12]

Thus, there is considerable evidence to warrant the conclusions that the I. Q. remains relatively constant throughout the age range represented by the pupils in this study, and that the I. Q.'s obtained at varying times before the initial achievement tests are valid in evaluating the intelligence of the groups to be compared.

3. *Achievement Test Results*:

The tests that were available for use in determining changes in achievement following the removal of physical defects were those given as a part of the regular testing program of the Division of Educational Research and Results, of the Philadelphia Public Schools. Fortunately, a continuous beginning and end of term program of testing was carried on in the ability-grouped schools, and enabled the securing of successive test records in arithmetic, (fundamental operations), reading, and spelling. It was originally planned to use scores in a general English test, but as this test was given only in fifth and sixth grades, there

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[10] Lewis M. Terman, *The Intelligence of School Children*, New York, Houghton Mifflin Co., 1919, p. 140.
[11] Lewis M. Terman, *Ibid.*, p. 140.
[12] Cecile Colloton and Harold O. Rugg, *Ibid.*, p. 321.

were not enough corrections of defects in the fifth grades to warrant the continuance of this test as one of the criteria. Pupils' test papers were collected from schools by the Division of Research and made available for the transcription and recording of test scores, as needed. The scores were personally recorded by the writer on the data sheet, with such assistance as needed. Personal checkings of the transcription of these scores were made by the writer to insure the accuracy of the recordings.

A. ARITHMETIC TESTS:

In order to secure a measure of efficiency in teaching practices, a comprehensive City Survey in the fundamentals of arithmetic was made in June, 1929, by the Division of Educational Research. Separate tests were used in the different grade-sections, each test devised to measure the proficiency of the pupils in the end-products of instruction in arithmetic in these grade-sections. Specimen examples from these tests are reproduced in the Appendix, pages 121–123. Table 7 shows the median standard scores for the selected grades and schools. Individual variations occurred among schools, but the mean standard score of the entire group of selected schools is very close to the average city median standard score. Similar city-wide survey tests were given again in June, 1930. In September, 1930, a combined city survey and diagnostic test was used in all fourth, fifth, and sixth grades. The tests were given and marked by the teachers, and, in accordance with general directions from the Division of Educational Research, were checked by other teachers, and necessary corrections made before pupil scores were totaled or transcribed.

B. READING TESTS:

The Stanford Achievement Test in *paragraph meaning* was used by the Division of Educational Research in June, 1929, to measure reading ability in all schools in two of the ten districts in the city, and in selected grades in all the ability-grouped schools. It was subsequently given in September, 1930, to pupils of grades 4B, 5, and 6, in the ability-grouped schools, thus making an initial and final test for comparative purposes in grades 3B, 4, and 5 in this study. Grade scores were computed in accordance

with the standards furnished with the test. Table 8 shows that the average for schools A-F was slightly below the city results. The papers were marked and checked by the teachers of the pupils tested. The scores were recorded personally by the writer on the data sheets with such assistance as needed. Personal checks were made by the writer to insure the accuracy of the recording.

TABLE 7
MEAN STANDARD SCORES IN ARITHMETIC
JUNE, 1929
SELECTED SCHOOLS AND GRADES

GRADE	MEAN STANDARD SCORES*							
	SCHOOL A	SCHOOL B	SCHOOL C	SCHOOL D	SCHOOL E	SCHOOL F	TOTAL SCHOOLS A-F INC.	CITY MEDIANS
2B...	8.3	10.3	10.0	6.6	12.5	11.4	10.1	9.9
3A....	9.8	9.4	10.3	7.6	11.6	10.3	9.9	9.3
3B....	9.6	10.3	11.5	9.7	9.0	9.3	9.6	9.7
4A....	10.6	10.0	8.8	10.4	6.6	11.9	9.9	9.9
4B....	11.0	10.6	9.9	7.8	8.7	12.0	9.5	9.1
5A....	9.8	8.2	11.7	7.8	9.3	13.2	9.9	9.9
Mean.	9.9	9.8	10.4	8.3	9.6	11.4	9.8	9.6

* The method of deriving standard scores for the test results used in this study is explained later in this chapter, pages 49–52.

C. SPELLING TESTS:

Periodic tests in spelling have been given throughout the elementary schools by the Division of Educational Research. These tests have been given in the form of lists of twenty words from the Philadelphia Course of Study in Spelling that also appear in the Iowa Spelling Scale. City-wide spelling tests were given at the beginning of the September, 1929, term in grades 2 to 6. Table 9, p. 35, shows that the mean standard scores for Schools A-F (inc.) were almost identical with the city averages for the same test. The tests were given by the teacher according to directions supplied by the Division of Research. These directions instructed the teacher to pronounce the word, repeat it in the sentence supplied in mimeograph form with the list of words, and

TABLE 8

MEAN STANDARD SCORES IN STANFORD READING TEST—PARAGRAPH MEANING
JUNE, 1929

SELECTED SCHOOLS AND GRADES

GRADE	MEAN STANDARD SCORES AND GRADE SCORES*																
	SCHOOL A		SCHOOL B		SCHOOL C		SCHOOL D		SCHOOL E		SCHOOL F		TOTAL SCHOOLS A-F INC.		CITY MEDIAN		
	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD SCORE	GRADE SCORE	STANDARD GRADE SCORE
3A	12.3	4.3	8.9	3.4	9.3	3.4	8.0	3.1	12.2	4.3	9.3	3.5	10.0	3.8	10.1	3.8	3.5
3B	11.2	5.0	10.7	4.9	10.2	4.7	7.7	4.0	11.1	5.0	9.2	4.3	10.0	4.5	10.1	4.6	4.0
4A	12.3	5.2	10.7	4.7	10.0	4.4	9.1	4.0	12.5	5.3	11.1	4.7	10.9	4.7	12.0	5.2	4.5
4B	12.1	6.3	10.8	5.7	9.5	5.2	7.8	4.5	12.2	6.4	10.3	5.5	10.5	5.6	11.8	6.1	5.0
5A	13.0	6.8	10.0	5.7	10.7	5.8	7.4	4.7	13.0	6.8	10.9	5.8	10.8	5.8	12.0	6.3	5.5
Mean	12.2		10.2		9.9		8.0		12.2		10.2		10.4		11.2		

* The method of deriving standard scores for the test results obtained in this study is described later in this chapter, pages 49–52. The standard grade scores are taken from the standards of the Stanford Achievement Test, Paragraph Meaning.

conclude the reading of the sentence with one more pronouncement of the word.

The papers were marked by teachers and the marking checked. The transcription of the pupils' scores was made personally by the writer with such assistance as needed. The recording of the pupils' scores was personally checked by the writer to insure accuracy of the recording.

TABLE 9

MEAN STANDARD SCORES
SPELLING TESTS
SEPTEMBER, 1929

GRADE	MEAN STANDARD SCORES*							
	SCHOOL A	SCHOOL B	SCHOOL C	SCHOOL D	SCHOOL E	SCHOOL F	TOTAL SCHOOLS A-F INC.	CITY MEDIANS
3A....	9.0	9.9	9.1	5.5	12.3	11.4	9.9	10.2
3B....	10.3	9.0	10.0	7.9	11.4	10.1	10.0	9.8
4A....	10.2	9.5	9.9	6.0	11.5	11.6	9.8	10.0
4B....	8.8	10.4	9.4	7.0	10.9	11.4	10.0	10.4
5A....	9.4	10.4	9.9	6.8	11.1	12.2	9.9	10.3
5B....	9.9	7.2	9.4	8.0	11.1	12.3	10.2	10.0
Mean.	9.6	9.4	9.6	6.9	11.4	11.5	10.0	10.1

* The method used in deriving the standard scores for the test results obtained in this study is described later in this chapter, pages 49–52.

4. *Routine Medical Examination Data:*

A. RECORDS OF DEFECTS:

The records of the physical defects used in this study were personally transcribed from the primary records of the school physicians who made the examinations.

Periodic physical, or health, examinations are conducted,

"for the purpose of detecting variations from the normal that may interfere with the health, growth, or development of the child.[13]

In keeping with recommendations[14] regarding the conduct of

[13] S. L. Newmayer, *Op. cit.*, p. 73.
[14] George T. Palmer and Others, *A Health Survey of 86 Cities.* New York, American Child Health Association, 1925, p. 175.

physical, or health, examinations, this work in Philadelphia is performed by physicians who devote the entire mornings of all school days to school health service.

The School Code of Pennsylvania,[15] section 1501, requires an annual examination of every pupil in the public schools in the first-, second-, and third-class districts.

Section 1505 of the School Law specifies that medical inspectors give special attention to defective sight, hearing, teeth, or other disabilities or defects specified by the Commissioner of Health. In actual practice, inspection is made of eyes, ears, throat, nose, teeth, skin, hair, and posture. The existence of anemia, of involuntary muscular movement, and of obvious abnormalities are noted. The heart is examined to the extent of ascertaining the quality of the heart sounds, and the regularity and quality of the pulse beat. No attempt is made to examine the lungs, except in case of pupils in the senior high schools. Pupils remove coats and shoes, but are not undressed.

The defects chosen for purposes of this study were dental caries, defective vision (15-30 or less), diseased tonsils, and nasal obstruction. Defective hearing was not used because of the lack of audiometers for all examinations, and also the difficulty of securing enough corrections within a reasonable time among the schools concerned in this study. Anemia, heart disease, and nervous weakness were not chosen for separate defect groups because of the

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[15] *The School Law*, Department of Public Instruction, Harrisburg, Pa., Commonwealth of Pennsylvania, 1929, Section 1501, page 118, as follows:

"Every school district of the first, second, or third class* in this Commonwealth shall annually provide medical inspection of all pupils of its public schools by proper medical inspectors, to be appointed by the board of school directors of the district in sufficient number to conduct the required inspection in conformity with the standard requirements prescribed by the Commissioner of Health for the medical inspection of schools in such district. Such medical inspection shall be made in the presence of the parent or guardian of the pupil, when so requested by parent or guardian. All such medical inspectors shall be physicians legally qualified to practice medicine in this Commonwealth, who have had at least two years' experience in the practice of their profession, and shall be paid such amounts as the boards of school directors shall determine."

*1st Class Districts: population of 500,000 or more.

2nd Class Districts: population of 30,000 or more, but less than 500,000.

3rd Class Districts: population of 5,000 or more, but less than 30,000.

In 4th Class Districts (population of less than 4,000) the medical inspection is provided by the State Department of Health, at the expense of that Department

relatively small number of defects discovered. The presence or absence of these defects was noted, however, on the data sheets. Stoop shoulders, flat feet, and scoliosis were omitted chiefly because of the difficulty of securing adequate data concerning corrections.

The standards used by the school physicians in determining the presence or absence of physical defects are prescribed by the Director of Medical Supervision of the Philadelphia Public Schools as follows:

"a. Eyestrain: Defective vision (15-20 or less) with use of Snellen type, or subjective symptoms indicating eye strain (frequent headaches, tiring of eyes after reading, blurring of vision after reading, with some weight given to the fact of habitual car-sickness).

b. Diseased tonsils: Greatly excessive size, causing mechanical obstruction. Surface irregular, pitted and chronically inflamed. Corroborative evidence (a) cervical adenitis, especially in the absence of decayed teeth, (b) inflamed tonsillar pillars, indicating draining from the infected focus, (c) history of frequent sore throats, of past attacks of rheumatic pains, chorea, or heart disease.

c. Nasal obstruction: Inability to breathe freely through each nostril, especially with facial evidence indicative of habitual mouth breathing. Diagnostic judgment is suspended in the presence of an acute cold.

d. Dental caries: Noted by ordinary inspection, and the number of decayed teeth recorded.

e. Malnutrition: Underweight, poor quality (lack of solidity) of tissues, and poor nervo-muscular tone in sufficient degree. A condition of underweight, of 13 per cent or more, is assumed in itself to constitute malnutrition. (Excessive overweight (20 per cent or more) is also considered as a nutritional abnormality.)"[16]

Dental caries was recorded on the data sheet by noting the number of decayed teeth that were discovered. The average number of defective teeth per pupil in the selected schools and grades was found to be 2.87. For purposes of this study, teeth defects were divided into two groups, one group with 1–3 decayed

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[16] *Annual Report of the Division of Medical Inspection of Public Schools for Year Ending June 30, 1929.* Phila., Pa., Board of Public Education, School District of Philadelphia, 1929, pp. 15–16.

teeth, and the other group with 4 or more decayed teeth per pupil. The number of pupils in each of these groups is given in table 11, page 43. The average number of decayed teeth per pupil as recorded on the routine medical examination card was found to have been rather uniform throughout successive years. This corresponds with the conclusions of a study of continuity of teeth decay by the American Child Health Association, in which it was found that decay is periodic and is a function of the individual organism and not the tooth. It was found that,

"being in the mouth at the same time when a tooth decays, and so being subject to a common influence is the determining factor in the correlated decay of another tooth."[17]

Defective vision was recorded on the data sheets in terms of the degree of the defect. For purposes of this Study, 15-30 vision in both eyes was taken as the lower limit of the *defect group*. Cases of 15-20 vision were placed in the *no-defect group*. Where the vision of one eye was more defective than the other, the vision of the better eye was taken to represent the degree of defect. Thus, a pupil with 15-20 vision in one eye and less than 15-20 in the other, was placed in the *no-defect group*, on the basis of the vision of the better eye. Table 10 shows that the duration of the defective vision averaged 2.38 years, with a number of cases remaining uncorrected for 4, 5, and 6 successive years.

Defective tonsils and nasal obstruction were recorded on the data sheets in terms of the duration of the defects. No record was obtained regarding the severity of the defect. The standards used by medical examiners for determining nose and throat defects have been given on page 37. The average duration of hypertrophied, or diseased, tonsils recommended for treatment was found to be 2.85 years. Table 10 also shows that the average duration of nasal obstruction was 2.72 years.

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[17] Raymond Franzen, *Public School Aspects of Dental Decay in Children* New York, American Child Health Association, 1930, p. 19.

TABLE 10

DURATION OF DEFECTS RECOMMENDED FOR TREATMENT
SELECTED SCHOOLS AND GRADES, 1929

DEFECTIVE VISION (15-30 OR LESS IN BOTH EYES)		HYPERTROPHIED OR DISEASED TONSILS		NASAL OBSTRUCTION	
NO. OF DEFECTS	DURATION (YEARS)	NO. OF DEFECTS	DURATION (YEARS)	NO. OF DEFECTS	DURATION (YEARS)
121	1	135	1	57	1
130	2	68	2	89	2
102	3	96	3	78	3
44	4	71	4	23	4
20	5	60	5	30	5
9	6	19	6	10	6
		5	7	2	7
Total 426	Avg. 2.38	Total 454	Avg. 2.85	Total 289	Avg. 2.72

Table reads as follows: 121 cases of defective vision in the selected schools and grades were reported for the first time in 1929; 130 cases were reported in 1929, for the second successive year; 102 cases were reported in 1929, for the third successive year, etc.

B. RECORDS OF CORRECTIONS:

Data concerning corrections of physical defects were obtained personally by the writer from the records of the school nurses. In accordance with the usual practice, the school physicians, at the time of the routine medical examination, entered a statement of the pupils' physical defects in the "School Medical Record Book," which is provided for the purpose. The school nurses copied these defects on a small printed form known as the "Record of Defects and Treatment," using a separate form for each pupil. Three months after the medical examination, these records of defects and their subsequent correction, or non-correction, were sent to the central office of the Division of Medical Inspection, where the data needed for this study were obtained.

One of the difficulties encountered by the American Child Health Association in its health survey of 86 American cities was the lack of standardization as to what constitutes a correction.[18]

[18] George T. Palmer and Others, *Op. cit.*, p. 181.

In the Philadelphia public schools this difficulty is largely avoided by the standard practice instructions which have been issued to the nurses. The standard practice instructions which are pertinent to this study include the following:

"(a) Acceptance of child's statement that defect has been treated: Nurses should verify the statement of children that defects have been treated, if verification is possible. In dental cases and tonsil cases, the mouth and throat should be inspected, using a tongue depressor, if necessary.

"(b) Children who have been examined for glasses but do not get them, and children listed for tonsil operations which have not occurred when the case cards have been turned in, are to be designated as 'not treated'. (Provision is made for the report of these subsequent treatments as 'amended cases', at which time the necessary data regarding the treatment is to be supplied.)

"(c) Dental Cases:

(1) If some of the carious teeth, but not all, are treated, the case is 'improved'.

(2) If the treatment is simply the cauterization of stumps of temporary teeth, then the case is 'improved'.

(3) If all carious teeth are either extracted, or filled, then the case is 'cured'.

"Note: It sometimes happens that when the child is taken to the dentist, more carious teeth are discovered than originally noted by the medical inspector. In such event, the nurse should record the larger number of carious teeth on the case card (Form M22), make a note that the dentist found carious teeth, and apply the above rules to the carious teeth found by the dentist."[19]

An audit of the nurses' work is conducted from time to time by the Division of Medical Inspection. A number of "cured" cases is selected at random from those turned in to the central office by the nurses. The names of these pupils, together with the nature of the defect and the date of correction, are given to the medical supervisors. These supervisors call the pupils to the infirmary and check up on the corrections, note the results, and return their report to the central offices. The high degree of accuracy obtained in records of corrections is favorable to this study.

[19] *Bulletin to Nurses, No. 103* (Sept. 1929), Division of Medical Inspection, Phila., Pa., Board of Public Education, School District of Philadelphia.

A number of checks on the accuracy of the corrections was made personally by the writer in connection with the specific physical defects selected for study. In connection with defective vision, the records of glasses furnished by the City Eye Dispensary were personally examined. No additional cases were discovered by this procedure and the dates of correction furnished by the nurses tallied exactly in regard to the "month" during which the glasses were furnished. Records were also obtained from the principals of the selected schools regarding the wearing of glasses by the pupils who had obtained them. This check-up showed that sixteen pupils were reported by teachers as not wearing their glasses at all. These cases, consequently, were not included in the "corrected" group.

School nurses' records of the removal of the tonsils and adenoids include the name of the hospital in which the operation was performed. In many cases, the nurses arrange for these operations and occasionally escort the pupils to the hospital for examination and treatment. A letter was sent to each hospital so listed, requesting information concerning the date of the operation. This verification was especially made to check up on the reports of operations obtained by questioning pupils about the removal of this defect within the time limits of this study. In a few cases, the hospitals reported the date of the operation as prior to the initial tests in June, 1929, and consequently these cases were not included in the "corrected" group.

In checking corrections of dental caries, 257 clinical charts of pupils treated in Philadelphia Dental Dispensaries were examined personally by the writer, and the dentists' records of fillings and extractions obtained from them. For other dental corrections, there is every reason to believe that the school nurses' reports possess a high degree of accuracy.

C. SELECTION OF DEFECT GROUPS:

The results of the routine medical examinations and subsequent corrective work have been presented in Tables 11, 12, and 14, pages 43, 44, and 46, respectively. From among the nineteen sub-divisions into which these cases were divided, the following were chosen for purposes of determining the changes in achievement between the initial and final tests:

1. Dental Caries (1-3 decayed teeth), Corrected and Uncorrected.
2. Dental Caries (4 or more decayed teeth), Corrected and Uncorrected.
3. Defective Vision (15-30 or less), Corrected and Uncorrected.
4. Diseased Tonsils, Corrected and Uncorrected.
5. Nasal Obstruction, Corrected or Uncorrected.
6. No Defect Recorded.

Four of the sub-divisions (namely 13 to 16), Table 11, were not included among the ones listed above because they represented combinations of vision and nose and throat defects. Furthermore, they could not be chosen for separate study because of the relatively small number of cases in them.

Malnutrition and overweight defects were not chosen for separate study because adequate data were not obtainable regarding corrections. A study of these defects would need a much more frequent weighing of the subjects than was possible in this study. In order to reduce the possibility of disturbing or complicating factors within the defect groups which were chosen for study, all cases of nutritional disturbances were excluded from them. These included the cases which were thirteen per cent or more underweight, and twenty per cent or more overweight. The actual number of these cases excluded is given in Table 11.

D. NUMBER OF DEFECTS:

Table 12 shows the number of defective teeth, defective vision, and nose and throat defects found by the school medical examiners among the pupils in this study. Table 13 is included for comparative purposes, and gives the number of all classes of defects for the city as a whole. Table 14 shows the distribution of physical defects among the six selected schools after corrections had been obtained.

5. *Attendance Data and Teachers' Marks:*

Attendance data, teachers' end-of-term ratings in conduct, effort, present standing, and arithmetic, reading, and spelling were obtained from the pupils' roll-book leaves for the school year

TABLE 11

CLASSIFICATION OF CORRECTED AND UNCORRECTED PHYSICAL DEFECTS AT CONCLUSION OF THIS STUDY SHOWING THE DEFECT GROUPS INTO WHICH THE CASES WERE ASSEMBLED AND THE NUMBER OF SEVERE CASES OF UNDERWEIGHT AND OVERWEIGHT THAT WERE ELIMINATED FROM EACH GROUP.

PHYSICAL DEFECT GROUPS	NUMBER OF CASES			
	WITHOUT NUTRITIONAL DISTURBANCES	UNDERWEIGHT (13% OR MORE)	OVERWEIGHT (20% OR MORE)	TOTAL
1. Dental Caries, corrected (1-3 decayed teeth)...	171	20	5	196
2. Dental Caries, uncorrected (1-3 decayed teeth).....	726	46	31	803
3. Dental Caries, improved (1-3 decayed teeth)...	90	3	5	98
4. Dental Caries, corrected (4 or more decayed teeth).....	197	27	8	232
5. Dental Caries, uncorrected (4 or more decayed teeth).....	314	19	16	349
6. Dental Caries, improved (4 or more decayed teeth).....	38	0	1	39
*7. Defective Vision, corrected (15–30 or less).	103	3	8	114
*8. Defective Vision, uncorrected (15–30 or less).	174	14	7	195
*9. Hypertrophied or diseased tonsils, corrected	75	8	1	84
*10. Hypertrophied or diseased tonsils, uncorrected.....	113	10	3	126
**11. Nasal obstruction, corrected.....	35	6	1	42
**12. Nasal obstruction, uncorrected.....	116	4	3	123
*13. Defective vision, corrected, and diseased tonsils, uncorrected...	8	1	0	9
*14. Defective vision, uncorrected, and diseased tonsils, corrected.....	6	2	0	8
*15. Defective vision corrected, and diseased tonsils, corrected.....	6	0	0	6
*16. Defective vision uncorrected, and diseased tonsils, uncorrected...	18	2	2	22
17. Malnutrition (13% or more underweight)...		42		42
18. Overweight (20% or more overweight)....			54	54
19. No defect recorded.....	699			699
Total.....	2,889	207	145	3241

*With or without dental caries, corrected or uncorrected, only.

**With or without diseased tonsils and dental caries, corrected or uncorrected, only.

Table reads as follows: Among the pupils examined in the six selected schools, 171 pupils had 1–3 defective teeth corrected, 20 had 1–3 defective teeth corrected, and, at the same time, were 13% or more overweight, and 5 had 1–3 defective teeth corrected, and, at the same time were 20% or more overweight, thus making a total of 196 pupils.

TABLE 12

Defects Recommended for Treatment—Selected Schools and Grades

Defect	Cases							
	School A	School B	School C	School D	School E	School F	Total Schools A-F	
	No.	No.	No.	No.	No.	No.	No.	%
Defective Vision (15-30 or less)	53	72	106	81	54	60	426	11.2
Hypertrophied, or Diseased Tonsils	115	55	78	80	59	67	454	12.0
Nasal Obstruction	76	38	34	61	46	34	289	7.6
Dental Caries (1-3 defective teeth)	298	258	252	213	253	242	1516	40.0
Dental Caries (4 or more defective teeth)	131	106	144	155	134	131	801	21.1
Number of Pupils Examined	698	638	655	636	599	562	3788	

1928–1929 and 1929–1930. These records were transcribed personally by the writer in the selected schools, with such assistance as needed. Personal checks were made by the writer to insure accuracy of the work.

TABLE 13

DEFECTS RECOMMENDED FOR TREATMENT, PHILADELPHIA PUBLIC SCHOOLS, SCHOOL YEAR ENDING JUNE 30, 1929[20]

(No. of Pupils Examined: 261,344)

DEFECT	NUMBER OF CASES
Teeth	158,061
Eye	28,024
Nose and Throat	61,425
Ear	2,450
Orthopedic	13,055
Nutrition	25,199
Heart	1,782
Nervous System	599
Gastro-Intestinal	31
Skin	15,930
Acute Illness and Accidents	6,193
*Miscellaneous	2,614
Total	315,363

* Includes bronchitis, eneuresis, goitre, not vaccinated (parents notified), speech defectives (without mental defect), miscellaneous.

Teachers are required to indicate reasons for absence upon the pupils' roll-book leaves, calling upon the attendance officers for investigation or verification of those reasons, as needed. Provision is made upon the roll leaves for recording the attendance officer's report concerning the reasons for absences. In obtaining the absences for illness for this study, the attendance officer's records were used wherever they appeared upon the roll-book leaves. Total absence is recorded on the back of the roll leaves in terms of total number of sessions absent.

Conduct, effort, present standing, and unsatisfactory ratings in arithmetic, reading, and spelling are judgment marks entered

[20] *Annual Report of the Division of Medical Inspection of Public Schools for Year Ending June 30, 1929.* Philadelphia, Pa., Board of Public Education, 1929, pp. 25–28.

TABLE 14

DISTRIBUTION OF CORRECTED AND UNCORRECTED PHYSICAL DEFECTS AMONG SIX SELECTED SCHOOLS AT CONCLUSION OF STUDY

PHYSICAL DEFECTS	NUMBER OF CASES						
	SCHOOL						
	A	B	C	D	E	F	A-F
1. Dental Caries, corrected... (1–3 decayed teeth).....	58	17	26	11	29	30	171
2. Dental Caries, uncorrected (1–3 decayed teeth).....	127	138	101	80	134	146	726
3. Dental Caries, improved... (1–3 decayed teeth).....	25	17	18	3	17	10	90
4. Dental Caries, corrected (4 or more decayed teeth)	44	19	44	22	36	32	197
5. Dental Caries, uncorrected (4 or more decayed teeth).	39	25	58	58	77	57	314
6. Dental Caries, improved... (4 or more decayed teeth).	13	6	1	4	4	10	38
*7. Defective Vision, corrected (15–30 or less).....	15	17	24	11	20	16	103
*8. Defective Vision, uncorrected (15–30 or less)	21	29	47	29	13	35	174
*9. Hypertrophied or diseased tonsils, corrected.....	6	3	22	7	18	19	75
*10. Hypertrophied or diseased tonsils, uncorrected.....	30	7	26	5	10	35	113
**11. Nasal Obstruction, corrected.....	17	8	5		3	2	35
**12. Nasal Obstruction, uncorrected.....	37	11	17	26	24	1	116
*13. Defective vision, corrected, and diseased tonsils, uncorrected.....	1	2	2	2	1		8
*14. Defective vision, uncorrected and diseased tonsils, corrected.....	2		4				6
*15. Defective vision, corrected and diseased tonsils, corrected.....			5			1	6
*16. Defective vision, uncorrected and diseased tonsils, uncorrected.....	2	1	3	5	4	3	18
17. No defect recorded.....	87	161	106	87	124	134	699

* With or without dental caries, corrected or uncorrected, only.

**With or without diseased tonsils and dental caries, corrected or uncorrected, only.

Table reads as follows: At the conclusion of the study, records for 58 corrected cases of dental caries (1-3 defective teeth) had been obtained from School A, 17 from School B, 26 from School C, etc. At the same time, for comparison with the corrected group, records of 127 uncorrected cases of dental caries (1–3 defective teeth) had been obtained from School A, 138 from School B, 104 from School C, etc.

monthly by the teacher, together with a term summary at the end of each semester. Conduct and effort are recorded as letter grades: E=excellent; G=good; F=fair; P=poor; V.P.=very poor. Present standing is rated numerically, with 9=excellent; 8=good; 7=fair; 6=poor; 5=very poor. Unsatisfactory subject ratings are indicated by "X" in the proper space opposite the name of the subject.

C. Treatment of Data:

1. *Age Records:*

The ages of the pupils, as recorded in columns 12 and 13 on the data sheet, were calculated from the date of birth to the nearest half year by means of the Baltimore Age Calculator.[6] For statistical purposes, this age was translated into monthly deviations above or below the grade medians given in Table 5, page 28, and recorded in column 14 as plus or minus deviations from this measure of central tendency. As age was one of the factors which was partialed out in the calculations of relationships between the correction or non-correction of physical defects and gains or losses in achievement, it was necessary to avoid negative quantities in connection with this factor. As no deviations were found as large as minus 30, this number was added to all the deviations and the algebraic sum recorded in column 15 on the data sheet.

2. *Intelligence Records:*

As previously explained on page 30, some of the intelligence quotients used in this study were obtained from the Haggerty Intelligence Examinations, Delta I, and others from the Otis Classification Test. By the use of statistical procedures, the intelligence quotients obtained from these two tests were equated.[7,8] In describing the standard deviation method of equating scores in different intelligence tests, the method used in this study, Woodworth states that:

"it is assumed to be fair to compare the individual with the group average as a standard in terms of group variability, and further to compare the result so obtained in different tests."[21]

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[21] R. S. Woodworth, *Op. cit.*, p. 110.

From the records of 1036 pupils whose intelligence quotients were obtained from the Haggerty Intelligence Examination, Delta I and the Otis Classification Test, in the six selected schools, a chart was prepared so that the Haggerty intelligence quotients could be changed into equivalent Otis Scores.

Briefly, the method consisted of obtaining standard measures for the raw intelligence quotients by the use of Kelley's[22] formula for standard measures, as follows: $z_1 = \frac{X_1 - M_1}{\sigma_1}$ and $z_2 = \frac{X_2 - M_2}{\sigma_2}$, in which:

z_1 and z_2 are the standard measures of the two series.

X_1 and X_2 are the respective intelligence quotients.

M_1 and M_2 are the means of the two series of intelligence quotients.

σ_1 and σ_2 are the standard deviations of the two series.

Then let a sigma score of 50 represent the mean of the I. Q.'s, and 60 equal 1 sigma above and 40 equal 1 sigma below. The mean for the Haggerty test was 92.88 and $\sigma = 15.90$. One sigma above $= 92.88 + 15.90$ or 108.78. One sigma below $= 92.88 - 15.90$, or 76.98. On suitable cross-ruled paper, these three points were plotted and the line for the Haggerty test drawn through these points. The mean for the Otis test was 95.62 and $\sigma = 12.95$. One sigma above $= 108.57$ and one sigma below $= 82.67$. These three points were also plotted and the line for the Otis test drawn through them. The scores were then equated as follows: An intelligence quotient of 119 from the Haggerty Intelligence Test had a sigma score of 66.43. The line for the sigma score of 66.43 cut the line for the Otis test at I.Q. 117. Therefore, the 119 I.Q. on the Haggerty test was considered to be equivalent to 117 on the Otis test.

In determining relationships between the correction and non-correction of physical defects and gains or losses in achievement, intelligence was the second factor which was eliminated, or held constant by partial correlations. As stated in the previous para-

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[22] Truman L. Kelley, *Statistical Method*, New York, The Macmillan Co., 1924, p. 115.

graph, age was the other factor which was partialed out. The method by which the partial correlations were obtained is described later in this chapter, pages 53–59. In order to facilitate the work done on the Hollerith printing tabulator in the calculation of zero order coefficients of correlation between intelligence and age, and intelligence and changes in achievement, all I. Q.'s were reduced to two digit numbers by dividing them by 5. This value was then recorded in column 17 on the data sheet.

3. *Achievement Test Results:*

A. CALCULATION OF STANDARD SCORES:

The comparison of raw scores or measures is valid only when they are expressed in the same units and obtained under similar conditions.[23] In order to compare the results of arithmetic tests given in different grades and in order to make such combinations of achievement scores as needed, the raw scores were transformed into standard scores by Kelley's "equivalence of successive percentiles method". In discussing the value of this method, Kelley states that,

"unless it has been experimentally determined that relationships between the two series are rectilinear, or curvilinear, according to a known law, a more accurate total set of equivalents may be expected from this method than from the ratio, or the standard deviation methods."[24]

Thus, in the situations involved in this study, no more concise relationship between variables can be stated than that a group of arithmetic abilities are distributed about the same as reading or spelling abilities. The relationships cannot be stated in algebraic formulas.

The necessary percentiles were obtained on a comptometer, by successive summations of the products obtained by multiplying each frequency by the reciprocal of the total number of cases in the distribution. As scholastic abilities are assumed to fit the

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[23] Truman L. Kelley, *Op. cit.*, p. 109.
[24] Truman L. Kelley, *Ibid.*, p. 118.

probability curve,[25] each series was equated, not to any one of them, but to a normal distribution.[26] This can be done by using Kelley's formula[27] for the mean deviation of a portion of a unit normal distribution: $d = \frac{z_1 - z_2}{q_1 - q_2}$, in which d = the required mean deviation, q_1 and q_2, the proportions lying beyond the upper and lower limits respectively of the class involved, and z_1 and z_2 are the ordinates for these proportions as given in Kelley's "K-W" tables.[28] In actual procedure, the mid-points of a portion of a unit normal distribution were used in obtaining the raw standard scores, except for the scores at the extremes of the distribution, which were calculated by means of the formula given above.

The actual procedure used is briefly outlined as follows: The percentiles were equated to a normal distribution by obtaining the sigma units corresponding to successive percentiles as given for a six sigma distribution in Rugg's Table VI, "Percentile scores to be assigned to test problems or questions which correspond to various percentages of pupils who fail to solve problems or questions correctly."[29] These values were then changed from a scale ranging from 0–6 to one ranging from 0–20 by dividing each score by .3.

In a spelling test, for example, the percentile value for the upper limit of raw score 11 was 26.789, and the lower limit was 23.109. Sigma units in Rugg's Table VI corresponding to these percentile values were found to be 2.39 and 2.27 respectively. The mid-point for the mean deviation for this portion of the unit normal distribution was 2.33. When divided by .3 in order to change from a scale of 0–6 to one from 0–20, the raw standard score was found to be 7.77 or a smoothed score of 8.

For calculation of the extremes of a unit distribution, the

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[25] Harold O. Rugg, *Statistical Methods Applied to Education*, New York, Houghton Mifflin Co., 1927, p. 396.
[26] Truman L. Kelley, *Op. cit.*, p. 120.
[27] Truman L. Kelley, *Ibid.*, p. 101.
[28] Truman L. Kelley, *Ibid.*, pp. 373–385.
[29] Harold O. Rugg, *Op. cit.*, Table VI, pp. 396–400.

formula[26] $d = \frac{z_1 - z_2}{q_1 - q_2}$ was used. For the tail of a distribution, z_2 and $q_2 = 0$, so the formula[30] becomes $\frac{z}{q}$ and the values can readily be obtained from Kelley's "K–W" tables.[27] For example, to find the mean deviation for the tail of the distribution of spelling scores used in this illustration, namely, for score 20, $q = .106$ $(q = 1 - p)$, $z = .1831$ and $\frac{z}{q} = 1.727$. As this value was derived from Kelley's "p" scale, 3 was added to it to change it into a $\pm 3\sigma$ scale, thus making the value 4.727. In order further to change it into a scale ranging from 0–20, this derived value was divided by .3, giving a raw standard score of 15.76 for the raw test score 20. As this value was nearer 16 than 15, the smoothed standard score 16 was assigned to raw test score 20.

For raw test score 19, $q_1 = .231$, and $q_2 = .106$. Corresponding values for z_1 and z_2 in Kelley's "K–W" tables were found to be .3044 and .1831, respectively. Substituting in the formula $d = \frac{z_1 - z_2}{q_1 - q_2}$, we find that $d = .970$. Following the procedure outlined in the preceding paragraph, $\frac{3 + .970}{.3} = 13.23$. As this was nearer 13 than 14, the smoothed standard score 13 was assigned to raw test score 19.

Diagram I, p. 52, illustrates graphically the method of calculating standard scores as described in the preceding paragraphs.

All standard score values were entered personally by the writer in the proper places upon the data sheets with such clerical assistance as was required. Adequate checking was personally made by the writer to insure the accuracy of this work.

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[30] Truman L. Kelley, *Op. cit.*, p. 100.

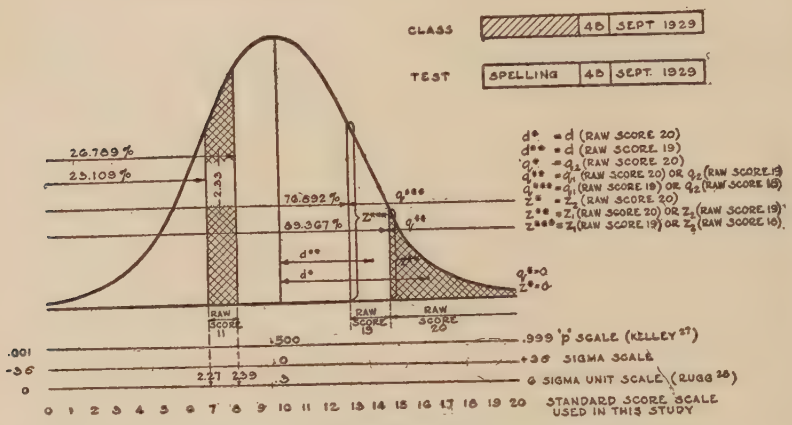

DIAGRAM I

NORMAL CURVE, ILLUSTRATING STEPS IN CALCULATION OF STANDARD SCORES

B. DETERMINATION AND EVALUATION OF CHANGES IN ACHIEVEMENT:

(1) By differences between standard scores:

Algebraic differences between standard scores in initial and subsequent tests were calculated and recorded on the data sheets for the following tests:

1. Arithmetic fundamentals, June 1929 and June 1930.
2. Arithmetic fundamentals, June 1929 and Sept. 1930.
3. Reading, June 1929 and Sept. 1930.
4. Spelling, Sept. 1929 and June 1930.
5. Spelling, Sept. 1929 and Sept. 1930.
6. Arithmetic and Reading combined, June 1929 and Sept. 1930.

In order to facilitate the work done on the Hollerith printing tabulator in the calculation of zero order coefficients of correlation between gains or losses in achievement and age, and gains or losses in achievement and intelligence, all negative values were changed into positive quantities by adding 10 to each difference obtained in connection with arithmetic, reading, and spelling tests taken separately, and 20 to each difference obtained when

arithmetic and reading results were combined. These derived values were then recorded in other columns on the data sheet.

(2) By determination of relationships between the correction or non-correction of physical defects and gains or losses in achievement:

Changes in achievement following the removal of physical defects were evaluated in terms of relationships (coefficients of correlation) between the correction or non-correction of the defects and gains or losses in achievement.

A multiplicity of factors very likely enters into such a complex relationship as gains or losses in school achievement. In a study of this type, regardless of whether cause and effect relationships are ascribed to the variable under consideration, attention should be directed to other variables which may or may not influence the results. Such factors include the following:

1. Age
2. Intelligence
3. Schools
4. Teachers
5. Curriculum
6. Attendance
7. Conduct
8. Effort
9. Sex
10. Race
11. Home Conditions
12. Repetition of a grade

The degree to which some of these factors may be associated in a causal way with school achievement has been studied by others. Courtis[31], in a study of 8–15-year-old children in grades 3–8, in three Detroit, Michigan, public schools, concluded that a pupil's ability to succeed in school was conditioned primarily by age and intelligence. In accounting for a ten per cent error of prediction, Courtis allotted seven per cent to imperfections of the measuring instruments. This left but three per cent to account for the combined distinctive effects of all other factors, such as teaching ability, social status, emotional control, home influnce, etc.

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[31] Stuart A. Courtis, *Why Children Succeed*, Detroit, Michigan, Courtis Standard Tests, 1925, p. 201.

The results of several other studies suggest the possibility of a rather small total general effect upon school achievement of such factors as social-economic status, teacher influence, sex, and race. Heilman, for example, using the Chapman-Sims Socio-Economic Scale, the Stanford Achievement Test, and the Stanford-Binet Intelligence Scale with a group of 828 ten-year-old pupils in the Denver, Colorado, schools concluded that:

"probably 50 per cent of the variation in educational age was due to such hereditary factors as had been measured; less than 13 per cent of the variation to school training; not over one per cent to the socio-economic status of the home; and about 36 per cent, to such hereditary and environmental factors as had not been accounted for."[32]

Taylor[33] concluded from a comparison of the achievement records in arithmetic and reading of 105 elementary school classes, grades four to eight, and the ratings of the teachers who were responsible for the instruction during the first semester of 1923–24, that the teachers' influence, during any one semester, affected only very slightly the outcome of each semester of instruction. When several semesters or years were considered, the correlation between teacher influence and variation in educational age approximated zero, probably because the pupil was exposed to both "good" and "bad" teaching as he progressed from teacher to teacher. Taylor concluded,

"that the quality of the teaching received is a fluctuating possession of a child or class and one almost impossible to identify."[34]

Baldwin[35] found the median increments in composite scores for

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[32] J. D. Heilman, "The Relative Influence Upon Educational Achievement of Some Hereditary and Environmental Factors," *Twenty-seventh Yearbook of the National Society for the Study of Education, Part II*, Bloomington, Ill., Public School Publishing Co., 1928, pp. 35–36.

[33] Howard Taylor, "Influence of the Teacher on Relative Class Standing in Arithmetic Fundamentals and Reading Comprehension," *Twenty-seventh Yearbook of the National Society for the Study of Education, Part II*, Bloomington, Ill., Public School Publishing Co., 1928, pp. 97–110.

[34] Howard Taylor, *Ibid.*, p. 110.

[35] Bird T. Baldwin, "Educational Growth of School Children," *Journal of Educational Psychology*, Volume XIX (November, 1928) p. 526.

boys and girls in the Stanford Achievement Test to show insignificant sex differences over a period of three years devoted to the study. Yoder[36] reviewed a number of racial studies of intelligence and achievement, and concluded that the consensus of scientific thought finds no proof of racial inferiority or superiority.

Furthermore, for purposes of this study it was not believed that the influence of other factors for which no statistical evaluation was attempted would operate materially upon any one of the "corrected," "uncorrected," or "no defect" groups, to the exclusion of the others. In order to offset the effects of the repetition of a grade upon school achievement, all non-promoted pupils were excluded from the groups that were used in this study.

The major emphasis, therefore, in the statistical treatment of the results of this study was directed toward the determination of relationships between the correction or non-correction of the physical defect and gains or losses in achievement, with the control, or elimination of the factors of age and intelligence. This was done by finding the partial correlation or "net" relationship between the corrected and uncorrected groups and the gains or losses in achievement, when the factors of age and intelligence, which might increase or decrease the true correlation, have been partialed out or held constant.[37]

In brief, the pupils who formed the subjects of this study were divided into three groups, namely, the "corrected" group, the "uncorrected" group, and the "no-defect" group. The four major variables for each of these groups were chosen as follows:

1. The defect—"corrected," "uncorrected," or "no-defect".
2. Gains or losses in achievement (differences in standard scores).
3. Age, in monthly deviations above or below grade median ages.
4. Intelligence quotients.

The partial correlation formula[38] for the relationship between

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[36] Dale Yoder, "The Question of Racial Differences," *Journal of Educational Psychology*, Volume 19 (October, 1928) p. 470.

[37] Henry E. Garrett, *Statistics in Psychology and Education*, New York, Longmans, Green and Co., 1926, p. 221.

[38] Henry E. Garrett, *Ibid.*, p. 249.

variables 1 and 2 with the influence of variables 3 and 4 eliminated, or held constant, is as follows:

$$r_{12.34} = \frac{r_{12.3} - r_{14.3} \cdot r_{24.3}}{\sqrt{1 - r^2_{14.3}} \cdot \sqrt{1 - r^2_{24.3}}}$$

This formula called for the finding of three partial coefficients of correlation of the first order, and six zero order coefficients of correlation as follows:

$$r_{12.3} = \frac{r_{12} - r_{13} \cdot r_{23}}{\sqrt{1 - r^2_{13}} \cdot \sqrt{1 - r^2_{23}}}$$

$$r_{14.3} = \frac{r_{14} - r_{13} \cdot r_{34}}{\sqrt{1 - r^2_{13}} \cdot \sqrt{1 - r^2_{34}}}$$

$$r_{24.3} = \frac{r_{24} - r_{23} \cdot r_{34}}{\sqrt{1 - r^2_{23}} \cdot \sqrt{1 - r^2_{34}}}$$

Graphically these intercorrelations are expressed in Diagram II, on opposite page.

For three of the zero order correlations outlined above, namely r_{23} (Gains or Losses, and Age), r_{24} (Gains or Losses, and IQ), and r_{34} (IQ and Age), graduated, or quantitative, series of measures were obtainable for both variables. The product-moment method of correlation was therefore available for finding the coefficients of correlation between them. These were calculated by the Philadelphia Office of the Recording and Statistical Corporation, from punched cards, by the Mendenhall-Warren-Hollerith Correlation Method.[39] Accuracy in punching the cards was checked by another operator on a checking machine devised for checking purposes. All comptometer work was checked by a second operator at each successive step in the calculation of the coefficients of correlation.

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[39] Richard Warren and Robert M. Mendenhall, *The Mendenhall-Warren-Hollerith Correlation Method*, Columbia University Statistical Bureau, Document No. 1, New York, Columbia University, 1929, p. 248.

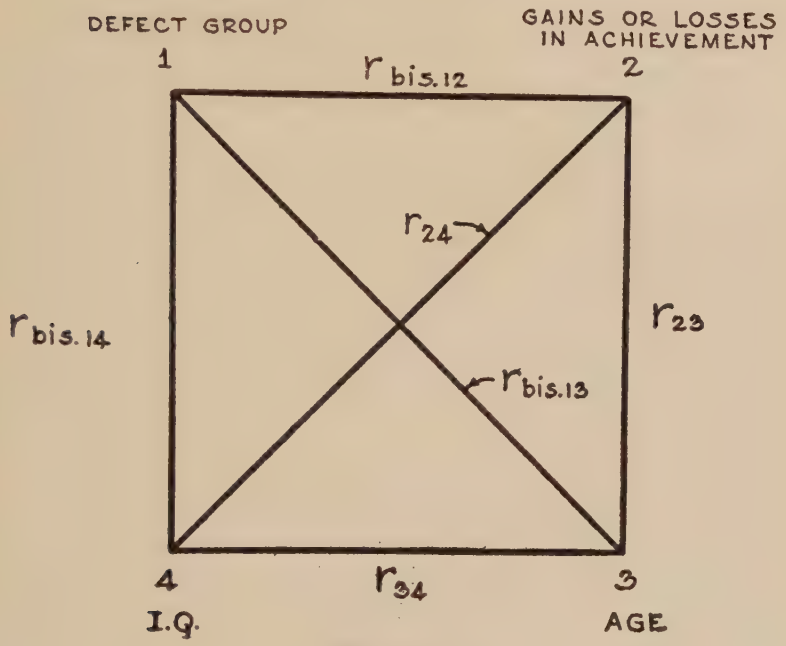

DIAGRAM II

INTERCORRELATIONS

In the three remaining first order correlations, namely, r_{12} (defect, corrected or uncorrected, and gains or losses in achievement), r_{13} (defect, corrected or uncorrected, and age), and r_{14} (defect, corrected or uncorrected, and intelligence), the defect variable was qualitative, or dichotomous, while the others were quantitative. Assuming that the defect, or dichotomous, distribution was really a continuous trait, normal in distribution, and for which only categorical information could be obtained, the relationship between the two variables was obtained by the calculation of *biserial r*, the formula[40] for which is as follows:

$$r_{bis.} = \frac{(M_2 - M_1)pq}{\sigma z}, \text{ in which}$$

[40] Truman L. Kelley, *Op. cit.*, p. 248.

M_1 = mean of first part of dichotomous trait
M_2 = mean of second part of dichotomous trait
p = proportion of cases in first part of dichotomous trait
q = proportion of cases in second part of dichotomous trait
z = ordinate at point of truncation of a normal distribution, cutting off p — proportion of cases.
σ = standard deviation of the total distribution.

The *probable error* was used as a measure of the reliability or unreliability of the relationships found between the correction or non-correction of the physical defects and changes in achievement. In the partial correlation formulas previously stated, it will be noted that they were derived from three bi-serial coefficients of correlation and three product-moment coefficients of correlation, therefore:

"the practical difficulties of determining a probable error formula for this situation are well nigh insurmountable."[41]

For purposes of reference, however, the corresponding zero order probable errors are included in the tables of partial correlations. The probable error of bi-serial r was calculated from the following formula, derived from Kelley's formula for standard error.[42]

$$\text{P. E.}_{\text{bis.}}\, r = \frac{.6745\left(\frac{\sqrt{pq}}{z} - r^2\right)}{\sqrt{N}}$$

The values of pq and z, as explained earlier in this chapter, were readily obtained from Kelley's "K–W" tables. The probable errors of the product-moment coefficients of correlation were obtained by the use of the formula:[43]

$$\text{P.E. } r = .6745\left(\frac{1-r^2}{\sqrt{N}}\right)$$

The probable errors of the coefficients of correlation were useful in determining the limits outside of which it is very unlikely the true value would fall. As Rugg states:

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[41] Truman L. Kelley, *Letter to Author.*
[42] Truman L. Kelley, *Op. cit.*, p. 249.
[43] Harold O. Rugg, *Op. cit.*, p. 230.

"statistical practice has tended to set the criterion that the coefficient of correlation should be at least three times as large as the probable error; this largely on the grounds that it is very improbable that the true value of r falls outside r ± 3 P. E. More conservative practice insists upon r being four times P. E."[44]

Thus, to insure a satisfactory degree of reliability of the computed measures:

"conservative practice insists that the coefficient of correlation be at least four times its probable error."[45]

4. *Attendance Data and Teachers' Marks:*

Absence from school has been presented for comparative purposes in terms of a percentile value which represents the relationship between the actual amount of absence and the total number of days in the school year. It was obtained by dividing the total number of days of absence by the total possible number of days' attendance for the year.

Differences in conduct, effort, and present standing were presented in terms of averages which represent the relationship between the actual ratings recorded and maximum possible ratings for the year. In order to obtain these values, the letter ratings for conduct and effort were first translated into a numerical scale in which E = 5, G = 4, F = 3, P = 2, VP = 1. Present standing was already recorded on a numerical scale, in which 9 = E, 8 = G, 7 = F, 6 = P, VP = 5.

Teachers' end-of-term "unsatisfactory" ratings in arithmetic, reading, and spelling were also presented in terms of averages which represent the relationship between the actual number of unsatisfactory ratings and the maximum possible number of unatisfactory ratings for the year.

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[44] Harold O. Rugg, *Op. cit.*, p. 272.
[45] Harold O. Rugg, *Op. cit.*, p. 231.

CHAPTER IV

Results

The data collected in this study yielded information concerning a number of changes following the correction of defective vision, diseased tonsils, nasal obstruction, and dental caries, as follows:

1. Changes in achievement in arithmetic, reading, and spelling.
2. Changes in end-of-term ratings of teachers in conduct, effort, present standing, and "crosses" (unsatisfactory subject ratings) in arithmetic, reading, and spelling, as recorded by teachers on pupils' report cards.
3. Changes in amount of time lost from school through absence for illness, and total absence.
4. Changes in rate of growth, as measured by net monthly gains in weight.

A. Relationships Between Physical Defects and School Achievement:

After the data had been gathered, a preliminary study was made to determine relationships between the presence or absence of the physical defects and achievement in arithmetic and reading. The partial coefficients of correlation that were obtained between "defective" and "non-defective" groups, and achievement in arithmetic and reading, with age and intelligence partialed out, are given in Table 15.

In regard to defective vision (15-30 or less), this coefficient of partial correlation was found to be −.07. As explained in the previous chapter:

"statistical practice has tended to set the criterion that the coefficient of correlation should be at least three times its probable error; this largely on the grounds that it is very improbable that the true value of r falls outside r ± 3 P. E. More conservative practice insists r being four times P. E."[1]

Because of the difficulties noted in the previous chapter, page 58, in connection with the determination of a probable error for a

[1] Harold O. Rugg, *Op. cit.*, p. 272.

partial correlation derived from bi-serial and product-moment zero order correlations, the corresponding zero order coefficients of correlation and their probable errors have been included in table 15, and in all subsequent lists of coefficients of correlation.

This coefficient of correlation between the presence or absence of defective vision, and achievement in arithmetic and reading, $-.07$, is less than four times $\pm.037$, the probable error of its corresponding zero order coefficient of correlation, and fails, therefore, to meet this criterion of reliability.

TABLE 15

RELATIONSHIPS BETWEEN PHYSICAL DEFECTS AND ACHIEVEMENT AS SHOWN BY COEFFICIENTS OF PARTIAL CORRELATION BETWEEN THE DEFECTIVE AND NON-DEFECTIVE GROUPS AND ACHIEVEMENT IN ARITHMETIC AND READING WITH AGE AND INTELLIGENCE PARTIALED OUT

	NUMBER OF CASES		COEFFICIENTS OF PARTIAL CORRELATION*	CORRESPONDING ZERO ORDER COEFFICIENTS OF CORRELATION AND THEIR PROBABLE ERRORS
	DEFECTIVE GROUP	NON-DEFECTIVE GROUP		
Dental Caries (1–3 decayed teeth).....	566	409	$-.003$	$-.03 \pm .027$
Dental Caries (4 or more decayed teeth).	275	409	$-.01$	$-.03 \pm .032$
Defective Vision (15–30 or less).....	472	409	$-.07$	$-.12 \pm .037$
Diseased Tonsils.....	107	409	$-.06$	$-.06 \pm .042$
Nasal Obstruction.....	86	409	$-.02$	$-.05 \pm .045$

* The negative coefficients of correlation indicate that the defective groups made lower scores in achievement than the "non-defective" groups.

The chances that the true value of the coefficient of correlation lies within:

" ± 1 P. E. are 1 to 1 (50 per cent of the measures fall within $\pm$ 1 P.E.)

" $\pm$ 2 P. E. are 4.5 to 1 (82.26 per cent of the measures fall within $\pm$ 2 P. E.)

" $\pm$ 3 P. E. are 21 to 1 (95.70 of the measures fall within $\pm$ 3 P. E.)

" $\pm$ 4 P. E. are 142 to 1 (99.30 of the measures fall within $\pm$ 4 P. E.)[2]"

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[2] Harold O. Rugg, *Ibid.*, p. 231.

A noteworthy report on relationships between acuity of vision and scholarship is that of the London County Council for 1904, based upon examinations of 32,000 boys and 29,000 girls. Cornell's analysis of a section of this report, dealing with the vision of 5157 ten-year-old children, shows that, "with the exception of a very small number of very precocious children, the vision is progressively better with the scholarship of the children; and also, the cases of bad vision are relatively more frequent among the more backward children."[3]

Thus, when four times the probable error, ($\pm$.037) or $\pm$.148 is added to, or subtracted from, the coefficient of correlation, $-$.07, the resulting coefficients of correlation, .08 and $-$.22 are rather low positive or negative values. The true relationship is not likely to be as high as .08 or as low as $-$.22. While this suggests the possibility of a negative relationship between defective vision and achievement in arithmetic and reading, it is unlikely that there was either a very strong positive or negative association between these factors.

For diseased tonsils, the coefficient of partial correlation was found to be $-$.06, with $\pm$.042 as the probable error of its corresponding zero order coefficient of correlation. The coefficient of correlation, therefore, is less than four times this probable error. When four times the P. E. or $\pm$.168 is added to, or subtracted from the coefficient of correlation, the resulting coefficients of correlation, .11 and $-$.23 respectively, are rather small positive or negative values. It may be concluded therefore, that, while there may have been a negative association between diseased tonsils and achievement in arithmetic and reading, it is unlikely there was either a strong positive or negative association between these factors, as measured by the tests used in this study.

In reference to nasal obstruction, the coefficient of partial correlation, $-$.02, is less than $\pm$.045, the P. E. of its corresponding zero order coefficient of correlation. The probability is very slight, therefore, that there was a marked negative relationship between nasal obstruction and achievement in arithmetic and reading, as measured by the tests used in this study.

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[3] Walter S. Cornell, *Op cit.*, p. 227.

In connection with dental caries, the coefficient of partial correlation between the presence or absence of 1–3 defective teeth and achievement in arithmetic and reading, was found to be −.003. When the group with 4 or more defective teeth was compared with the non-defective group, the coefficient of partial correlation was found to be −.01. As both of these coefficients are less than the probable errors of their zero order coefficients of correlation, the probability is very slight that there was a marked negative relationship between dental caries and achievement in arithmetic and reading.

Results of some other studies likewise seem to point to comparatively slight positive or negative relationships between the presence of certain physical defects and school achievement. As previously noted in Chapter II, page 17, Mallory obtained rather low relationships between the presence of certain physical rather low coefficients of correlation between the presence of certain physical defects and school achievement.[4] Wessel, in a study of some of the social and economic relationships of the secondary school population, found that

"children with physical defects were successful in school subjects in approximately the same numbers as those without physical defects."[5]

mately the same numbers as those without physical defects."[4] Newmark[6] reports from a study of Normal School students, that no significant differences were found between pupils with or without physical defects in regard to achievement in high school subjects and achievement in Normal School as judged by practice teaching and scholastic standing. Cheyney studied factors which might possibly influence rate of progress through the grades and listed the physical defects selected for this study, namely, defective vision, dental defects, nasal obstruction and condition of the tonsils, among those

"factors for which no relationship was found which would be great enough to

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[4] James N. Mallory, *Op cit.*, p. 70.

[5] Herman M. Wessel, *The Secondary School Population in Some of Its Social and Economic Relationships*, Philadelphia, Pa., University of Pennsylvania, 1930, Doctorate Thesis, p. 98.

[6] David L. Newmark, *A Study of a Class in the Philadelphia Normal School*, Phila., Pa.; University of Pennsylvania, 1931, Doctorate Thesis, pp. 97–99, 107–108.

account for any significant per cent of the failure, except inasmuch as it reflected the I.Q. of the pupil."[7]

B. Relationships Between the Correction or Non-Correction of Certain Physical Defects and Changes in Achievement in Arithmetic, Reading, Spelling, and Other Factors:

For purposes of comparison, the pupils included under each physical defect were classified into three subdivisions, designated hereafter as the "corrected group," the "uncorrected group," and "no-defect group," respectively. The number of cases in each of these groups is given in Table 16, p. 66. The smaller number of cases available for use in determining changes in achievement, as compared with the total number of cases, is due to several reasons. About two hundred pupils were eliminated from the corrected and uncorrected groups because of nutritional disturbances, including those who were 13 per cent or more underweight, or 20 per cent, or more, overweight. The remaining eliminations were accounted for by absences of pupils from either the initial or subsequent tests, or because of non-promotion, or transfers, or withdrawals from the selected schools after the first tests had been given.

Table 16 likewise shows that the arithmetic tests given in June, 1929, and June, 1930, and the spelling tests in September, 1929 and June, 1930, were used to determine changes in achievement in these two subjects, following the correction of defective vision, diseased tonsils, and nasal obstruction. The scores in the arithmetic and reading tests in June, 1929 and September 1930 were combined to determine changes in achievement in these two subjects following the correction, or non-correction, of dental caries, defective vision, diseased tonsils, and nasal obstruction.

1. *Changes in Achievement in Arithmetic, Reading, Spelling, and other Factors Following the Correction of Defective Vision* ($^{15}/_{30}$ *or less*):

Table 17, page 67, "Changes in Achievement in Arithmetic Fundamentals as Shown by Differences between Mean Standard

[7] W. Walker Cheyney, *Rate of Progress and the I. Q.*, Phila., Pa., University of Pennsylvania, 1930, Doctorate Thesis, p. 85.

Scores, June 1929–June 1930," shows that the corrected group made a slight gain and that the uncorrected and no-defect groups made slight losses between the initial and final tests, as measured by differences between mean standard scores.

Table 19, page 69, "Changes in Achievement in Spelling as Shown by Differences between Mean Standard Scores, September 1929–June 1930", shows that the corrected, uncorrected, and no-defect groups all made slight gains between the initial and final tests, as measured by differences between mean standard scores. The differences were all extremely small, however, with that of the uncorrected group slightly in excess of the others.

Table 21, page 71, "Changes in Achievement in Arithmetic Fundamentals and Reading, June 1929–September 1930", shows gains for the corrected and no-defect groups and a loss for the uncorrected group between the initial and final tests, as measured by differences between mean standard scores.

These changes in achievement are given in Tables 18, 20, and 22, pages 68, 70, 72, respectively in terms of relationships, or coefficients of partial correlation, between the correction or non-correction of defective vision, and gains or losses in achievement in arithmetic, reading, and spelling, with the influence of age and intelligence partialed out. Table 18, based on results of the arithmetic tests given in June 1929 and June 1930, shows this coefficient of partial correlation between the corrected and uncorrected group, and gains or losses in arithmetic to be .04 with $\pm$.060 as the probable error of its corresponding zero order correlation. This indicates that, after an average period of time slightly in excess of one school term between the correction of the defect and the final test, the probability is very slight that there was a marked relationship between the correction or non-correction of defective vision, and gains or losses in arithmetic, as measured by the tests used in this study. Similar relationships were found between the corrected and the no-defect groups, and between the no-defect and uncorrected groups, and gains or losses in arithmetic, as shown by their coefficients of partial correlation, and probable errors, in the same table.

In connection with spelling, Table 20, the coefficient of partial correlation between the correction or non-correction of defective

TABLE 16

NUMBER OF CASES IN THE DEFECTIVE AND NON-DEFECTIVE GROUPS AT CONCLUSION OF STUDY

C = CORRECTED GROUP U = UNCORRECTED GROUP N.D. = NO DEFECT GROUP

PHYSICAL DEFECTS	TOTAL NUMBER OF CASES			NUMBER OF CASES								
				ARITHMETIC TESTS JUNE, 1929 AND JUNE, 1930			SPELLING TESTS SEPT., 1929 AND JUNE, 1930			ARITHMETIC AND READING TESTS JUNE, 1929 AND SEPT., 1930		
	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.
Dental Caries (1–3 decayed teeth)	171	726	699							91	334	358
Dental Caries (4 or more decayed teeth)	197	314	699							91	123	358
Defective Vision (15–30 or less)	103	174	2277	81	118	1427	71	118	1427	66	79	1071
Diseased Tonsils	75	113	2277	54	71	1427	36	17	1427	46	51	1071
Nasal Obstruction	35	116	2277	22	73	1427	18	73	1427	16	58	1071
Diseased Tonsils Nasal Obstruction	110	229	2277							62	109	1071

TABLE 17

CHANGES IN ACHIEVEMENT IN ARITHMETIC FUNDAMENTALS AS SHOWN BY DIFFERENCES BETWEEN MEAN STANDARD SCORES

JUNE, 1929—JUNE, 1930

PHYSICAL DEFECTS	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	MEAN STANDARD SCORES		DIFFERENCE*	MEAN STANDARD SCORES		DIFFERENCE*	MEAN STANDARD SCORES		DIFFERENCE*
	JUNE 1929	JUNE 1930		JUNE 1929	JUNE 1930		JUNE 1929	JUNE 1930	
Defective Vision 15–30 or less)	10.44	10.53	.09	10.27	10.03	−.24	10.14	10.08	−.06
Diseased Tonsils	9.67	9.79	.12	9.81	10.64	.83	10.14	10.08	−.06
Nasal Obstruction	10.01	10.33	.32	9.43	9.63	.20	10.14	10.08	−.06

* A positive difference indicates a gain between initial and final tests, in terms of mean standard scores. A negative difference indicates a loss between initial and final tests, in terms of mean standard scores.

TABLE 18

Changes in Achievement in Arithmetic Fundamentals June, 1929—June, 1930

As Shown by Coefficients of Partial Correlation Between the Defective and Non-Defective Groups and Gains or Losses in Achievement with Age and Intelligence Partialed Out

C = Corrected Group U = Uncorrected Group N.D. = No-Defect Group

Physical Defects	Average Number of Months Between Correction and Final Test	Coefficients of Partial Correlation*			Corresponding Zero Order Coefficients of Correlation and Their Probable Errors*		
		C. and U.	C. and N.D.	N.D. and U.	C. and U.	C. and N.D.	N.D. and U.
Defective Vision (15–30 or less)	6	.04	.02	.00	.07 ± .060	.02 ± .036	.02 ± .032
Diseased Tonsils	7	−.19	−.03	−.12	−.18 ± .077	−.03 ± .022	−.11 ± .004
Nasal Obstruction	6	.02	.07	−.04	.02 ± .096	.05 ± .006	−.04 ± .004

* A positive coefficient of correlation indicates that the first group named tended to make greater gains in achievement than the other group with which it is paired. A negative coefficient of correlation indicates that the second group named tended to make greater gains in achievement than the other group with which it is paired.

TABLE 19

CHANGES IN ACHIEVEMENT IN SPELLING AS SHOWN BY DIFFERENCES BETWEEN MEAN STANDARD SCORES

SEPT., 1929—JUNE, 1930

PHYSICAL DEFECTS	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	MEAN STANDARD SCORES		DIFFERENCE*	MEAN STANDARD SCORES		DIFFERENCE*	MEAN STANDARD SCORES		DIFFERENCE*
	SEPT. 1929	JUNE 1930		SEPT. 1929	JUNE 1930		SEPT. 1929	JUNE 1930	
DefectiveVision (15–30 or less)	9.83	9.84	.01	9.98	10.03	.05	10.36	10.37	.01
Diseased Tonsils	10.77	9.69	−1.08	10.72	10.67	−.05	10.36	10.37	.01
Nasal Obstruction	8.85	11.50	2.65	9.51	9.82	.31	10.36	10.37	.01

* A positive difference indicates a gain between the initial and final tests, in terms of mean standard scores. A negative difference indicates a loss between the initial and final tests, in terms of mean standard scores.

TABLE 20

Changes in Achievement in Spelling
Sept., 1929—June, 1930

As Shown by Coefficients of Partial Correlation Between the Defective and Non-Defective Groups and Gains or Losses in Achievement With Age and Intelligence Partialed Out

C = Corrected Group U = Uncorrected Group N.D. = No-Defect Group

Physical Defects	Average Number of Months Between Correction and Final Test	Coefficients of Partial Correlation*			Corresponding Zero Order Coefficients of Correlation and Their Probable Errors*		
		C. and U.	C. and N.D.	N.D. and U.	C. and U.	C. and N.D.	N.D. and U.
Defective Vision (15–30 or less)	5	−.03	−.03	.00	−.05 ± .062	−.03 ± .038	−.01 ± .032
Diseased Tonsils	6	−.03	−.03	.00	−.06 ± .087	−.03 ± .047	.01 ± .004
Nasal Obstruction	5	.23	.29	−.04	.22 ± .098	.28 ± .024	−.05 ± .004

* A positive coefficient of correlation indicates that the first group named tended to make greater gains in achievement than the other group with which it is paired. A negative coefficient of correlation indicates that the second group named tended to make greater gains in achievement than the other group with which it is paired.

TABLE 21

CHANGES IN ACHIEVEMENT IN ARITHMETIC FUNDAMENTALS AND READING AS SHOWN BY DIFFERENCES BETWEEN MEAN STANDARD SCORES
JUNE, 1929—SEPT., 1930

PHYSICAL DEFECTS	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	MEAN STANDARD SCORES		DIFFERENCE*	MEAN STANDARD SCORES		DIFFERENCE*	MEAN STANDARD SCORES		DIFFERENCE*
	JUNE 1929	SEPT. 1930		JUNE 1929	SEPT. 1930		JUNE 1929	SEPT. 1930	
Dental Caries (1–3 decayed teeth)	19.86	20.61	.75	20.33	20.39	.06	20.10	20.30	.20
Dental Caries (4 or more decayed teeth)	19.42	19.43	.01	20.21	21.29	1.08	20.10	20.30	20
Defective Vision (15–30 or less)	20.04	20.51	.47	19.46	18.53	−.93	20.10	20.30	.20
Diseased Tonsils	20.44	20.59	.15	18.96	19.85	.89	20.10	20.30	.20
Nasal Obstruction	20.88	20.81	−.07	20.79	20.55	−.24	20.10	20.30	.20
Diseased Tonsils and Nasal Obstruction	20.55	20.65	.10	19.94	20.21	.27	20.10	20.30	.20

* A positive difference indicates a gain between the initial and final tests, in terms of mean standard scores. A negative difference indicates a loss between the initial and final tests, in terms of mean standard scores.

TABLE 22

CHANGES IN ACHIEVEMENT IN ARITHMETIC FUNDAMENTALS AND READING
JUNE, 1929—SEPT. 1930

AS SHOWN BY COEFFICIENTS OF PARTIAL CORRELATION BETWEEN THE DEFECTIVE AND NON-DEFECTIVE GROUPS AND GAINS OR LOSSES IN ACHIEVEMENT WITH AGE AND INTELLIGENCE PARTIALED OUT
C = CORRECTED GROUP U = UNCORRECTED GROUP N.D. = NO-DEFECT GROUP

DEFECT GROUPS	AVERAGE NUMBER OF MONTHS BETWEEN CORRECTION AND FINAL TEST	COEFFICIENTS OF PARTIAL CORRELATION*			CORRESPONDING ZERO ORDER COEFFICIENTS OF CORRELATION AND THEIR PROBABLE ERRORS*		
		C. AND U.	C. AND N.D.	N.D. AND U.	C. AND U.	C. AND N.D.	N.D. AND U.
Dental Caries (1–3 decayed teeth)	8	.09	.12	.03	.09 ± .046	.11 ± .043	−.02 ± .032
Dental Caries (4 or more decayed teeth)	8	−.13	.01	−.16	−.14 ± .057	.01 ± .045	−.16 ± .041
Defective Vision (15–30 or less)	9	.18	.04	.10	.18 ± .069	.03 ± .040	.12 ± .038
Diseased Tonsils	10	−.12	.00	−.08	−.09 ± .085	−.004 ± .005	−.07 ± .004
Nasal Obstruction	9	−.05	−.03	.02	.02 ± .112	−.02 ± .006	.05 ± .041
Diseased Tonsils and Nasal Obstruction	10	−.02	−.02	−.01	−.02 ± .066	−.01 ± .041	−.01 ± .034

* A positive coefficient of correlation indicates that the first group named tended to make greater gains in achievement than the other group with which it is paired. A negative coefficient of correlation indicates that the second group named tended to make greater gains in achievement than the other group with which it is paired.

vision, and gains or losses in spelling, with age and intelligence partialed out was found to be −.03. This is smaller than ±.062, the probable error of its corresponding zero order coefficient of correlation. The probability is very slight, therefore, that there was a marked negative relationship between the correction or non-correction of defective vision and gains or losses in spelling, with age and intelligence partialed out.

In Table 22, "Changes in Achievement in Arithmetic and Reading, June 1929–September 1930," the coefficient of partial correlation between the correction or non-correction of defective vision and gains or losses in arithmetic and reading, with the influence of age and intelligence partialed out, was found to be .18. The corresponding zero order coefficient of correlation was also found to be .18 ±.069, showing that the relationship falls short of being four times its probable error, the conservative criterion of reliability for a coefficient of correlation. When four times the probable error, or ±.28 was added to, or subtracted from, the coefficient of correlation .18, the resulting coefficients of correlation, .46 and −.10, respectively, became rather small positive or negative values. The true relationship, therefore, was not likely as high as .46, or as low as −.10. While this suggests the possibility of a positive relationship, it is unlikely that, after an average period of nine months between the correction of the defect and the final test, there was a strong positive or negative association between the correction, or non-correction, of defective vision, and gains or losses in arithmetic and reading, as measured by the tests used in this study.

In connection with conduct, effort, present standing (general average), "crosses" (unsatisfactory subject ratings) on reports, and absences from school, as given in Tables 23–27, averages were obtained for two successive school years, 1928–1929 and 1929–1930. The corrections of defects in this study were obtained during the school year 1929–1930. The averages for 1928–1929, therefore, have been included for purposes of comparison.

The changes in conduct, effort, and present standing, following the correction or non-correction of defective vision, as shown in Tables 23, 24, 25, pages 74, 75 and 76, respectively were very

small. The largest change was in connection with the conduct of the "corrected" vision group, which decreased from 8.0 to 7.6 between 1928–1929 and 1929–1930. This decrease had no apparent effect, however, upon the teachers' judgments of achievement, for the "corrected" group increased in present standing, during this same period, from 7.4 to 7.5, while the "uncorrected" and "no-defect" groups showed no change. Thus, it may reasonably be concluded that the correction, or non-correction, of defective vision was not followed by any marked positive or negative changes in conduct, effort, or present standing, as recorded by teachers on pupils' report cards.

As explained in the previous chapter, unsatisfactory work in a subject of study is indicated by making an X (cross) on the pupil's roll leaf and report card in the spaces provided for this purpose. The number of "crosses" in arithmetic, reading, and

TABLE 23

CHANGES IN END-OF-TERM RATINGS IN CONDUCT
1928–29 AND 1929–30
9 = EXCELLENT 8 = GOOD 7 = FAIR 6 = POOR 5 = VERY POOR

PHYSICAL DEFECTS	END-OF-TERM RATINGS								
	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	1928–29	1929–30	DIFFERENCE*	1928–29	1929–30	DIFFERENCE*	1928–29	1929–30	DIFFERENCE*
Dental Caries (1-3 decayed teeth).....	8.0	8.0	.0	7.9	8.0	.1	8.0	8.0	.0
Dental Caries (4 or more decayed teeth).	8.0	8.0	.0	7.9	8.0	.1	8.0	8.0	.0
Defective Vision	8.0	7.6	−.4	7.9	8.0	.1	8.1	8.0	−.1
Diseased Tonsils.....	7.9	8.0	.1	7.9	8.0	.1	8.1	8.0	−.1
Nasal Obstruction.....	7.8	7.9	.1	8.1	8.0	−.1	8.1	8.0	−.1
Diseased Tonsils and Nasal Obstruction..	8.0	8.2	.2	8.0	8.1	.1	8.1	8.0	−.1

* A positive difference indicates higher end-of-term ratings in *conduct* in the 1929–30 school year than in the 1928–29 school year. A negative difference indicates lower end-of-term ratings in *conduct* in the 1929–30 school year than in the 1928–29 school year.

TABLE 24

CHANGES IN END-OF-TERM RATINGS IN EFFORT 1928–29 AND 1929–30

9 = EXCELLENT 8 = GOOD 7 = FAIR 6 = POOR 5 = VERY POOR

PHYSICAL DEFECTS	END-OF-TERM RATINGS								
	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	1928–29	1929–30	DIFFERENCE*	1928–29	1929–30	DIFFERENCE*	1928–29	1929–30	DIFFERENCE*
Dental Caries (1–3 decayed teeth).....	8.0	8.0	.0	7.9	7.9	.0	7.9	7.9	.0
Dental Caries (4 or more decayed teeth).	7.9	8.0	.1	8.0	8.1	.1	7.9	7.9	.0
Defective Vision	8.0	8.0	.0	7.9	8.0	.1	7.9	8.0	.1
Diseased Tonsils.....	7.9	8.0	.1	8.0	7.9	−.1	7.9	8.0	.1
Nasal Obstruction.....	7.9	8.0	.1	8.0	8.0	.0	7.9	8.0	.1
Diseased Tonsils and Nasal Obstruction..	8.0	8.0	.0	8.0	8.1	.1	7.9	8.0	.1

* A positive difference indicates higher end-of-term ratings in *effort* in the 1929–30 school year than in the 1928–29 school year. A negative difference indicates lower end-of-term ratings in *effort* in the 1929–30 school year than in the 1928–29 school year.

spelling, for the pupils, in this study are given in Table 26 page 77 in terms of a percentage relationship between the actual number of crosses received and the total possible number of crosses that could have been given to the pupils included within the various groups. Thus, the corrected vision group, in 1928–29, received 11.5 per cent and in 1929–30, 11.4 per cent of the total possible number of crosses that could have been given to the pupils in the group. The decrease is negligible, representing as it does, a decrease of only one cross among the 81 pupils in the group. The uncorrected group received the same number of these end-of-term crosses during each of the two years for which the records were obtained. The no-defect group showed a slight increase, from 10.2 per cent to 11.4 per cent, during this time. It may be concluded, therefore, that the correction or non-correction of de-

TABLE 25

CHANGES IN END-OF-TERM RATINGS IN PRESENT STANDING 1928–29 AND 1929–30

9 = EXCELLENT 8 = GOOD 7 = FAIR 6 = POOR 5 = VERY POOR

PHYSICAL DEFECTS	END-OF-TERM RATINGS								
	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	1928–29	1929–30	DIFFERENCE*	1928–29	1929–30	DIFFERENCE*	1928–29	1929–30	DIFFERENCE*
Dental Caries (1–3 decayed teeth).....	7.4	7.5	.1	7.4	7.4	.0	7.5	7.5	.0
Dental Caries (4 or more decayed teeth).	7.5	7.5	.0	7.5	7.6	.1	7.5	7.5	.0
Defective Vision	7.4	7.5	.1	7.2	7.2	.0	7.4	7.4	.0
Diseased Tonsils.....	7.4	7.4	.0	7.3	7.4	.1	7.4	7.4	.0
Nasal Obstruction.....	7.3	7.5	.2	7.5	7.5	.0	7.4	7.4	.0
Diseased Tonsils and Nasal Obstruction..	7.3	7.5	.2	7.5	7.6	.1	7.4	7.4	.0

* A positive difference indicates higher end-of-term ratings in *present standing* in the 1929–30 school year than in the 1928–29 school year.

fective vision did not have any appreciable effect upon the number of crosses, or unsatisfactory end-of-term subject ratings, in arithmetic, reading, and spelling, as determined by the methods used in this study.

Absences from school for illness and the total absences are given in Tables 27 and 28, pages 78 and 79, respectively. The percentage values indicate the relationships between the actual number of days absent and the total number of school days for the year. Thus, the corrected vision group was absent from school, in 1929–30, 5.25 per cent of the total possible number of school days for the year. On the basis of 189 school days in 1929–30, this represents an average of 11.7 days absence for the year. During this same year, the uncorrected group was absent from school 3.03 per cent of the total number of school days, or an average of 9.9 days per school year.

TABLE 26

CHANGES IN NUMBER OF END-OF-TERM FAILURES IN ARITHMETIC, READING, AND SPELLING, AS RECORDED BY TEACHERS ON PUPILS' REPORTS 1928–29 AND 1929–30

PHYSICAL DEFECTS	END-OF-TERM RATINGS								
	CORRECTED GROUP			UNCORRECTED GROUP			NO-DEFECT GROUP		
	PER CENT*			PER CENT*			PER CENT*		
	1928–29	1929–30	DIFFERENCE†	1928–29	1929–30	DIFFERENCE†	1928–29	1929–30	DIFFERENCE†
Dental Caries (1-3 decayed teeth).....	8.3	7.9	−.4	11.6	11.5	−.1	10.2	11.0	.8
Dental Caries (4 or more decayed teeth).....	10.6	9.1	−1.5	8.1	8.0	−.1	10.2	11.0	.8
Defective Vision	11.5	11.4	− .1	12.5	12.5	.0	10.2	11.4	1.2
Diseased Tonsils.....	10.1	15.1	5.0	10.9	11.2	.3	10.2	11.4	1.2
Nasal Obstruction.....	9.8	8.3	−1.5	9.3	8.6	−.7	10.2	11.4	1.2
Diseased Tonsils and Nasal Obstruction..	10.2	11.0	.8	8.1	7.3	−.8	10.2	11.4	1.2

* Per Cent the actual number received is of total possible number that could be received, or the actual number received divided by the total possible number that could be received.

† A positive difference indicates a larger percentage of end-of-term failures in arithmetic, reading, and spelling in the 1929–30 school year than in the 1928–29 school year. A negative difference indicates a smaller percentage of end-of-term failures in these subjects in the 1929–30 school year than in the 1928–29 school year.

The difference between these averages is insufficient to account for differences in achievement between the groups. Odell[8] found that the per cent of time pupils attend school had practically no effect upon actual increases in achievement age except in cases of pupils whose attendance records were very low.

[8] C. W. Odell, Attendance and School Achievement, *Journal of Educational Research*, Vol. VIII, (December, 1923), p. 428.

TABLE 27

Changes in Absences from School 1928–29 and 1929–30

C = Corrected Group U = Uncorrected Group N.D. = No-Defect Group

Physical Defects	Per Cent* of Absence											
	Illness Only						Total Absence					
	1928–1929			1929–1930			1928–1929			1929–1930		
	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.
Dental Caries (1–3 decayed teeth)	4.28	4.33	4.39	2.64	3.34	3.21	5.59	6.87	6.53	4.63	5.52	5.55
Dental Caries (4 or more decayed teeth)	4.54	4.44	4.39	2.55	3.62	3.21	6.88	6.95	6.53	4.00	4.89	5.55
Defective Vision (15–30 or less)	3.81	3.91	4.38	2.85	3.46	3.21	6.21	6.76	7.13	5.25	6.06	5.29
Diseased Tonsils	5.05	4.64	4.38	4.90	3.32	3.21	7.84	7.17	7.13	5.94	5.37	5.29
Nasal Obstruction	2.76	5.26	4.38	2.13	5.01	3.21	5.83	6.96	7.13	7.32	5.07	5.29
Diseased Tonsils and Nasal Obstruction	4.46	4.97	4.38	4.19	4.23	3.21	6.80	6.75	7.13	6.29	4.96	5.29

* Per Cent the actual absence is of total number of days in school year, or the actual number of days' absence divided by the total possible number of days' absence for the school year.

TABLE 28

DIFFERENCES BETWEEN PER CENTS* OF ABSENCES IN TABLE 27 1928–29 AND 1929–30

C = CORRECTED GROUP U = UNCORRECTED GROUP N.D. = NO-DEFECT GROUP

PHYSICAL DEFECTS	DIFFERENCES†					
	ILLNESS ONLY			TOTAL ABSENCE		
	C.	U.	N.D.	C.	U.	N.D.
Dental Caries (1–3 decayed teeth).....	−1.64	−.99	−1.18	− .96	−1.35	− .98
Dental Caries (4 or more decayed teeth)...	−1.99	− .82	−1.18	−2.88	−2.06	− .98
Defective Vision..	− .96	− .45	−1.17	− .96	−. 70	−1.84
Diseased Tonsils.	− .15	−1.32	−1.17	−1.90	−1.80	−1.84
Nasal Obstruction	− .63	− .25	−1.17	1.49	−1.89	−1.84
Diseased Tonsils and Nasal Obstruction.....	− .27	− .74	−1.17	−.51	−1.79	−1.84

* See note at bottom of Table 27.

† A positive difference indicates a larger per cent of absence in the 1929–30 school year than in the 1928–29 school year. A negative difference indicates a smaller per cent of absence in the 1929–30 school year than in the 1928–29 school year.

2. *Changes in Achievement in Arithmetic, Reading, and Spelling, following the Removal of Hypertrophied, or Diseased Tonsils:*

Table 17, page 67, "Changes in Arithmetic Fundamentals as Shown by Differences between Mean Standard Scores, June 1929–June 1930", shows that the corrected and uncorrected groups made gains and the no-defect group made a slight loss between the initial and final tests, as measured by differences between mean standard scores. It will be noted that the gains were larger in the uncorrected than in the corrected group.

Table 21, page 71, "Changes in Achievement in Arithmetic and Reading as Shown by Differences between Mean Standard Scores, June 1929–September, 1930" shows that the corrected, uncorrected, and no-defect groups all made gains between the initial and final tests, as shown by differences between mean standard scores. It will be noted again that the gains of the uncorrected group exceeded those of the others.

Table 19, page 69, "Changes in Achievement in Spelling as Shown by Differences between Mean Standard Scores, September, 1929–June 1930", shows that the corrected and uncorrected groups made losses between the initial and final tests, as measured by differences between mean standard scores. The loss in the uncorrected group was less than that in the corrected group.

Thus, in terms of differences between mean standard scores of the initial and final tests, the gains, or losses seem to have favored the uncorrected group.

These differences in achievement are given in Tables 18, 20, and 22, pages 68, 70, 72, respectively in terms of relationships, or coefficients of partial correlations between the correction, or non-correction of diseased tonsils, and gains or losses in achievement in arithmetic, reading, and spelling. with the influence of age and intelligence partialed out. For arithmetic, June, 1929 and June, 1930, Table 18 shows this coefficient of partial correlation between the corrected and uncorrected groups, and gains or losses in arithmetic to have been $-.19$. This is less than four times $\pm .077$, the probable error of its corresponding zero order coefficient of correlation. When four times the probable error, or $\pm .308$ was added to, or subtracted from, the coefficient of correlation, the resulting coefficients of correlation became $+.12$ and $-.50$, respectively, indicating that the true relationship was probably between these limits. It was likely not as high as .12 or as low as $-.50$, which leads to the conclusion that, for an average period of time of seven months between the removal of the diseased tonsils and the final test there was probably a slight negative relationship between these factors.

In connection with spelling, the coefficient of partial correlation, $-.03$, between the correction and non-correction of diseased tonsils and changes in achievement in spelling, Table 20 was found to be less than $\pm .087$, the probable error of its corresponding zero order coefficient of correlation. This indicates that, after an average period of time equal to one school term between the correction of the defect and the final test, the probability is very slight that there was a marked negative relationship between the correction or non-correction of diseased tonsils and changes in achievement in spelling.

When arithmetic and reading scores were combined, the coefficient of partial correlation between the correction and non-correction of diseased tonsils and changes in achievement in these two subjects, with the influence of age and intelligence partialed out, was found to be −.12. Table 22 also shows the probable error of its corresponding zero order coefficient of correlation to have been ±.085. The coefficient of partial correlation is less than twice this probable error, and, therefore, falls short of meeting the conservative test of reliability that requires the coefficient of correlation to be at least four times its probable error. When four times the probable error, or ±.340 was added to, or subtracted from, the coefficient of partial correlation, the resulting coefficients of correlation, .20 and −.46 respectively, indicated that the true relationship was probably within these rather small positive on negative values. It may be concluded, therefore, that for an average period of time equal to ten months, or two school terms, between the correction of the defect and the final test, there may have been a slight negative association between the removal of diseased tonsils and gains in achievement in arithmetic and reading, as measured by the tests used in this study.

Thus, from the coefficients of partial correlation that have been found between the correction or non-correction of diseased tonsils, and changes in achievement in arithmetic, reading, and spelling, with age and intelligence partialed out, a rather persistent negative relationship may be noted from the results that have been obtained.

In connection with the correction or non-correction of diseased tonsils and averages in conduct, effort, and present standing, as given in Tables 23, 24, and 25, pages 74, 75, and 76 respectively, all differences were found to be slight, being in no case greater than .1 unit on a scale of 0–10, or 1 point on a scale of 0–100. It will be noted that the corrected and uncorrected groups increased their conduct averages from 7.9 to 8.0 while the no-defect group decreased from 8.1 to 8.0. In effort, the corrected group increased from 7.9 to 8.0, and the uncorrected group decreased from 8.0 to 7.9. In present standing, the corrected group received an average of 7.4 for both years, while the uncorrected group increased from 7.3 to 7.4 during this period. These differences are

so slight that no other conclusion seems to be justified than that the slight increase of the uncorrected group in present standing, as compared with no change in the corrected group, is in correspondence with the slight negative association suggested by the coefficient of partial correlation between the correction and non-correction of diseased tonsils and changes in achievement in arithmetic and reading.

As shown in Table 26, page 77, the number of "crosses", or unsatisfactory end-of-term subject ratings, in the corrected group increased from 10.1 to 15.1 per cent, while in the uncorrected group, they increased only from 10.1 to 11.2 per cent. This difference corresponds, in a measure, with the results previously cited, that, after an average period of time equal to seven months between the correction of the defect and the final ratings, there was a tendency for the uncorrected group to do better school work than the corrected group. The differences in absence between the corrected and uncorrected groups were not large enough to cause noticeable differences in achievement. In Tables 27 and 28, pages 78 and 79, respectively, it is shown that, in 1928–29, the absence of the defective group was greater than that of the non-defective group. In 1929–30, the corrected group was absent from school slightly more in total absence, and in absence for illness, than the uncorrected group. This may likewise be an indication that the full benefits of the correction have not yet been realized by the corrected group. Kaiser, from a ten-year study of 2200 tonsillectomies, concluded that, from a health standpoint, at least,

"the real value of removed tonsils and adenoids cannot be definitely established in a few years."[9]

With regard to school work, Kaiser also noted[10] that the removal of the tonsils seemed to help some pupils and not others. The differences in degrees of infection of the tonsils and consequent systemic infection may be partly responsible for differences in the reactions of different individuals within the corrective group. It may take longer for some to recover from the harmful

[9] Albert D. Kaiser, *Op. cit.*, pp. 837–841.
[10] Albert D. Kaiser, *Letter to Author.*

effects of these toxins. In others, the return to normal health may be more rapid and complete.

3. *Changes in Achievement in Arithmetic, Reading, Spelling, and Other Factors following the Correction of Nasal Obstruction*:

Table 17, page 67, "Changes in Achievement in Arithmetic Fundamentals as Shown by Differences between Mean Standard Scores, June 1929–June, 1930", shows that the corrected and uncorrected groups made slight gains and that the no-defect group made a slight loss between the initial and final tests, as measured by differences between mean standard scores. The gains in the corrected group somewhat exceeded those in the uncorrected group.

Table 19, page 69, "Changes in Achievement in Spelling as Shown by Differences between Mean Standard Scores, September 1920–June, 1930", shows that the corrected, uncorrected, and no-defect groups all made gains between the initial and final tests, as measured by differences between mean standard scores. It will be noticed that the gains of the corrected group greatly exceeded those of the other two groups.

Table 21, page 71, "Changes in Achievement in Arithmetic and Reading as Shown by Differences between Mean Standard Scores, June, 1929–September, 1930", shows that the corrected and uncorrected groups made losses and the no-defect group made a gain between the initial and final tests, as measured by differences between mean standard scores. The losses for the uncorrected group were a trifle larger than those of the corrected group.

Thus, in terms of differences between standard scores of the initial and final tests, the gains, or losses, seem to have principally favored the corrected group.

The coefficient of partial correlation between the correction and non-correction of nasal obstruction and changes in achievement in arithmetic, with the influence of age and intelligence partialed out (Table 18, page 68), was found to be .02. A similar coefficient of partial correlation for arithmetic and reading combined (Table 22, page 72), was found to be $-.05$. Both of these correlations were less than the probable errors of their corresponding zero

order coefficients of correlation. They fail therefore, to indicate whether there was a definite positive or negative relationship between the correction or non-correction of nasal obstruction, and changes in arithmetic and reading, as measured six to nine months after the corrections were made.

The coefficient of partial correlation between the correction or non-correction of nasal obstruction, and gains or losses in spelling, with the influence of age and intelligence partialed out was found to be .23. This value was less, however, than four times $\pm .098$, the probable error of its corresponding zero order coefficient of correlation. While this relationship, therefore, was not high enough to be regarded as definitely positive, it may be taken as an indication of a tendency for the correction of nasal obstruction to have been associated positively with growth in achievement in spelling.

In connection with conduct, effort, and present standing ratings, as given in Tables 23, 24, and 25, pages 74, 75, and 76, respectively, all differences in end-of-term averages were found to have been rather small, and suggest the lack of definite positive or negative association between the correction or non-correction of nasal obstruction and changes in these teacher ratings. The largest change occurred in the corrected group, which increased in present standing from 7.3 to 7.5 while the uncorrected group remained unchanged at 7.4

In number of "crosses," or end-of-term subject-failures in arithmetic, reading. and spelling (Table 26, page 77), the corrected group decreased 1.5 per cent as compared with a .7 per cent decrease in the uncorrected group. The differences were so slight, that it may be concluded, that, after an average period of time equal to slightly more than one school term after the correction of the defect and the final ratings, there was little evidence to show that the correction or non-correction of nasal obstruction had any appreciable effect upon changes in conduct, effort, present standing, and crosses in arithmetic, reading, and spelling.

In regard to nasal obstruction and absence from school, Tables 27 and 28, pages 78 and 79, respectively show that, in 1928–29, the physical defective groups were absent less than the no-defect group. In 1929–30, the corrected group was absent for illness less

than either the uncorrected and no-defect groups. On the other hand, when total absence was considered, the corrected group was absent from school more than either the uncorrected and no-defect groups. It may therefore be concluded that correction of nasal obstruction tended to reduce absences from illness, but had no appreciable influence upon the total absences.

Cornell investigated the mental improvement after operation of 63 cases of nasal obstruction, by inquiring among the teachers of the pupils, and by investigating the promotion records of these same children.

According to the statements of the teachers, the degree of improvement may be stated as follows:[11]

"Much improved after operation	19
"Improved after operation	25
"Mental condition unchanged	16
"Deteriorated after operation	1
"Much deteriorated after operation	2
	63

While this constituted an encouraging report, the record for promotions subsequent to the operations was distinctly less optimistic. This record is given by Cornell, as follows:[12]

"Cases Having Two Opportunities for Promotion since Operation (Operations, January to June, 1908)

Promoted twice	4
Promoted once and failed once	21
Failed twice	10

"Cases Having One Opportunity for Promotion since Operation (Operations, September to December, 1908)

Promoted	7
Failed	21
Total number investigated	63

Cornell's comment upon these promotion records is pertinent to the subject of changes in achievement following the removal of nasal obstruction, and is quoted as follows,

"Such a record totaling 36 promotions and 62 failures after removal of the nasal obstruction certainly explodes the theory that the removal of adenoids is the panacea for all juvenile delinquencies. That it causes great improvement

[11] Walter S. Cornell, *Op. cit.*, p. 277.
[12] Walter S. Cornell, *Ibid.*, p. 278.

in some cases as well as a noticeable average improvement is the consensus of teachers' opinions."[13]*

4. *Changes in Achievement in Arithmetic and Reading following the Correction of Diseased Tonsils and Nasal Obstruction:*

The changes in achievement in arithmetic and reading following the correction, or non-correction, of the combined nose and throat defects are given in Tables 21 and 22, pages 71 and 72, respectively. The coefficient of partial correlation between the corrected and uncorrected groups and gains or losses in arithmetic and reading, with the influence of age and intelligence partialed out, was found to have been $-.02$; the coefficient of partial correlation between the corrected and no-defect groups and gains or losses in these two subjects was also found to have been $-.02$; and the coefficient of partial correlation between the no-defect and the uncorrected groups and gains or losses in arithmetic and reading to have been $-.01$.

As all these coefficients of partial correlation were less than the probable errors of their corresponding zero order coefficients of correlation, the probability is very slight that there was a marked negative relationship between the correction, or non-correction of diseased tonsils and nasal obstruction, and gains or losses in arithmetic and reading, as measured by the tests used in this study.

In connection with averages in conduct, effort, and present defects, as shown in tables 23, 24, 25, pages 74, 75, 76, respectively, the changes were found to have been of slight degree. The corrected group increased in conduct (Table 23), from 5.0 to 8.2, made no changes in average for effort (Table 24), and increased in present standing (Table 25) from 7.3 to 7.5, suggesting that the association of increased achievement, as shown by present standing on pupils' report cards, was more closely connected with improvement in conduct than with effort.

In Tables 27 and 28, pages 78 and 79, respectively, it is shown that absences for illness, in 1928–29, were slightly greater in the

[13] Walter S. Cornell, *Ibid.*, p. 278.

* Note, page 82, somewhat similar report from Kaiser in connection with the removal of hypertrophied, or diseased, tonsils.

defective group than in the no-defect group. In 1929–30, the absences for illness in both the corrected and uncorrected groups still exceeded the no-defect group. Thus, the correction of the physical defects seemed to have little influence upon absences for illness.

5. *Changes in Achievement in Arithmetic and Reading, and Other Factors Following the Correction of Dental Caries:*

It was found that the average number of decayed teeth among those reported for dental caries was three per pupil. For purposes of comparison, pupils with dental defects were divided into two groups, those with 1–3 decayed teeth, and those with 4 or more decayed teeth.

The differences between median standard scores, Table 21, page 71, show that when 1–3 decayed teeth were considered, the gains for the corrected group exceeded those of the uncorrected group. When four or more decayed teeth were considered, the uncorrected group made larger gains than the corrected group.

The coefficient of partial correlation between the correction or non-correction of 1–3 decayed teeth, and gains or losses in arithmetic and reading, with the influence of age and intelligence partialed out, was found to be .09, with ±.046 as the probable error of the corresponding zero order coefficient of correlation. The coefficient of partial correlation therefore was less than four times this probable error, the criterion which has been given as a conservative measure of reliability of a coefficient of correlation. When four times this probable error, or ±.174 was added to, or subtracted from, the coefficient of correlation, the resulting coefficients of correlation .26 and −.08 were extremely low values and could be said to exhibit hardly more than a slight positive relationship between these factors.

The coefficient of partial correlation between the correction or non-correction of 4 or more decayed teeth and gains or losses in arithmetic and reading, with the influence of age and intelligence partialed out was found to be −.12 with ±.057 as the probable error of its corresponding zero order coefficient of correlation. This coefficient of correlation was likewise less than four times its

probable error. When four times the probable error, or ±.288, was added to, or subtracted from, the coefficient of correlation, the resulting coefficients of correlation, .11 and −.35 still remained quite small positive or negative values, and could be said to exhibit hardly more than a slight negative relationship between these factors.

The results for dental caries show, therefore, that, while there might have been a slight positive association between the correction of 1–3 decayed teeth, and gains in achievement in arithmetic and reading, the correction of a larger number of decayed teeth and gains in achievement in these two subjects tended to be negatively associated. Thus, these relationships tended to neutralize, or offset, each other. It therefore, seems safe to conclude, that, for an average period of time equal to eight months between the correction of dental defects and the final tests, there was no consistently positive or negative relationship between the correction and non-correction of dental caries, and gains or losses in arithmetic and reading, as measured by the tests used in this study.

An additional study was made of the relationships between the correction or non-correction of dental caries and changes in achievement in arithmetic and reading for pupils with six or more decayed teeth. This study disclosed no significant changes in the relationships which had been found for the group with four or or more decayed teeth. The coefficient of partial correlation between the correction or non-correction of four or more decayed teeth and changes in arithmetic and reading, with the influence of age and intelligence partialed out, was found to have been −.13, while that for the correction or non-correction of six or more decayed teeth was found to have been −.14.

In connection with changes in end-of-term ratings in conduct, effort, present standing, and number of "crosses" (unsatisfactory subject ratings) in arithmetic, reading, and spelling, Tables 23, 24, 25, 26, pages 74, 75, 76, and 77, respectively, the correction or non-correction of dental caries likewise showed somewhat varying, and neutralizing relationships. In "present standing," for example, Table 25, page 76, the increase of the corrected group, with 1–3 decayed teeth, corresponded to the positive association that was noted in connection with this group in a preced-

ing paragraph, and the increase in present standing in the uncorrected group, with four or more decayed teeth, corresponded to the suggestion of negative association that was noted in connection with the uncorrected group.

In Tables 27 and 28, pages 78 and 79, respectively, it will be noted that, in 1928–29, there were no marked differences in absences from school among the defective or non-defective pupils. In 1929–30, the corrected groups, regardless of the number of defective teeth, were absent from school for illness less than the uncorrected groups. A part of the difference may be associated with the elimination or reduction of toothache as a cause of absence for illness in the corrected groups.

C. Changes in Weight Following the Removal of Physical Defects:

Weighing and measuring forms an essential part of the routine medical examination of all Philadelphia public school pupils. The weights of the pupils in this study at the time of the routine medical examination and at the time of the final tests have been organized to show changes in weight among the defective and non-defective groups. The average time between weighings was ten months.

In order to conform more closely to natural cycles of growth and to conform to the procedure used in the Philadelphia Public School Nutrition Classes in obtaining similar data, the boys under 12 years of age have been placed in one group and boys 12 years and older in another. Girls under 10 years of age have likewise been placed in a separate group, and girls 10 years and older in another. The number of pupils in these groups is given in Table 29, page 91. The changes in weight have been presented in Table 30, page 92, in terms of the net gains in pounds per month. The average for a group was obtained by dividing the total net gain in pounds for the group by the total number of months between the weighings.

It will be noted from Table 30, that, for defective vision and dental caries, the net average gains per month were quite variable among the corrected, uncorrected, and no-defect groups. For example, with defective vision, the net average gain per month

was larger in the corrected group for boys under 12, and larger in the uncorrected group for boys over 12. Similarly, with dental caries, the net average gain per month was large in the corrected group for girls under 10 and larger in the uncorrected group for girls over 10. It may be concluded, therefore, that the net average gain per month in weight was not consistently, either favorably or unfavorably influenced, by the correction or non-correction of defective vision or dental caries.

When nose and throat defects were considered, it was found that the net average gains in weight per month were greater than those for the uncorrected group. It may therefore be concluded that the net average gains per month in weight were favorably influenced by the removal of diseased tonsils or nasal obstruction, when compared with the uncorrected groups.

TABLE 29

NUMBER OF PUPILS IN AGE GROUPS USED TO DETERMINE CHANGES IN WEIGHT FOLLOWING THE REMOVAL OF CERTAIN PHYSICAL DEFECTS IN ELEMENTARY SCHOOL PUPILS

C = CORRECTED GROUP U = UNCORRECTED GROUP N.D. = NO-DEFECT GROUP

PHYSICAL DEFECTS	NUMBER OF PUPILS											
	BOYS						GIRLS					
	UNDER 12 YEARS			12 YEARS AND OVER			UNDER 10 YEARS			10 YEARS AND OVER		
	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.
Dental Caries (1–3 decayed teeth)	52	265	234	0	24	18	46	121	131	17	84	107
Dental Caries (4 or more decayed teeth)	74	127	234	9	9	18	32	74	131	16	20	107
Defective Vision (15–30 or less)	32	46	808	2	6	64	18	29	434	19	35	258
Diseased Tonsils	27	38	808	2	3	64	18	29	434	8	10	258
Nasal Obstruction	10	40	808	1	2	64	5	28	434	8	16	258
Diseased Tonsils and Nasal Obstruction	37	78	808	3	5	64	23	57	434	16	26	258

Read table as follows: There were 52 boys under 12 years of age among the corrected cases of dental caries (1–3 decayed teeth), 265 boys under 12 years of age among the uncorrected cases of dental caries (1–3 decayed teeth), and 234 boys under 12 years of age in the no-defect group that was used as a control group with cases of dental caries (1–3 decayed teeth), etc.

TABLE 30

CHANGES IN WEIGHT FOLLOWING THE REMOVAL OF CERTAIN PHYSICAL DEFECTS IN ELEMENTARY SCHOOL PUPILS

NET AVERAGE GAINS PER MONTH*

C = CORRECTED GROUP U = UNCORRECTED GROUP N.D. = NO-DEFECT GROUP

PHYSICAL DEFECTS	NET AVERAGE GAIN PER MONTH (POUNDS)											
	BOYS						GIRLS					
	UNDER 12 YEARS			12 YEARS AND OVER			UNDER 10 YEARS			10 YEARS AND OVER		
	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.	C.	U.	N.D.
Dental Caries (1–3 decayed teeth)	.39	.42	.46		.63	.79	.63	.51	.54	.70	.86	.85
Dental Caries (4 or more decayed teeth)	.46	.44	.46	.56	.56	.79	.53	.46	.54	.67	.94	.85
Defective Vision (15–30 or less)	.56	.40	.43	.62	.98	.63	.58	.65	.52	.74	.72	.86
Diseased Tonsils	.58	.57	.43	.85	.63	.63	.74	.54	.52	.89	.86	.86
Nasal Obstruction	.56	.53	.43	1.11	.95	.63	.60	.50	.52	1.03	.61	.86
Diseased Tonsils and Nasal Obstruction	.51	.48	.43	.97	.76	.63	.71	.52	.52	.85	.71	.86

* $\frac{\text{Total Net Gain in Pounds}}{\text{Total Months Between Weighing}}$ = Net Average Gain per Month for Group.

CHAPTER V

Summary and Conclusions

A. Sources and Treatment of Data:

The conclusions presented herein relative to changes in achievement following the removal of certain physical defects have been derived from the records of about three thousand pupils in grades three to five, in six selected Philadelphia public schools. Data regarding defective vision (15-30 or less), diseased tonsils, nasal obstruction, and dental caries among these pupils were obtained from the records of the school medical examiners. Information regarding the correction of defects was chiefly obtained from the records of the school nurses. Pupil achievement in arithmetic, reading, and spelling was secured from tests that were given in these subjects as a part of the regular testing program of the Division of Educational Research and Results of the Philadelphia public schools. Changes in achievement were determined by differences between mean standard scores in initial and final tests, and evaluated by coefficients of partial correlation between the correction or non-correction of the physical defects and gains or losses in arithmetic, reading, and spelling, with the influence of age and intelligence partialed out. The data also yielded information concerning changes in teachers' end-of-term ratings in conduct, effort, and present standing (general average) of the pupils included in this study.

B. Limitations:

Attention is directed to the importance of interpreting the results and conclusions in the light of qualifying limitations to which they may be subject in varying degrees. The relationships between the correction or non-correction of the physical defects and changes in school achievement were determined from the records of pupils in the regular grades in a large city school system. The results were not influenced, therefore, by the achievement of pupils whose defects were serious enough to necessitate their transfer to a "special" class. Many cases of the poorest vision, for example, have been gathered into "sight-saving classes" for special instructional purposes.

The physical defects were noted by school physicians at the time of the regular annual routine physical examination of school pupils. Whether a more thorough health examination, in which the teeth were examined by a dentist or dental hygienist, the eyes by an oculist, and the nose and throat by specialists in this field of medical science, would cause a change in the defective and non-defective groups of sufficient extent to modify the results obtained in this study is a matter for conjecture. Such an examination by specialists would permit a more detailed classification of defects according to degrees of severity than was possible in this study and offers a worthy field for further investigation.

It should also be recognized that adaptations are possible in some cases in order to overcome detrimental effects of physical handicaps upon school achievement. Pupils with defective vision, for example, may be seated nearer to blackboards in order to lessen the handicaps of this physical defect. Greater effort may likewise be exerted occasionally by individuals to offset known handicaps.

Attention has been directed in an earlier chapter, pp. 53 ff., to the possible influences of a number of different factors upon a complex product such as school achievement. The influence of two of the most important of these factors namely, age and intelligence, has been eliminated, or held constant, by the partial correlation technique. The results are still subject, however, to the effects of the limitations to which these methods of accounting, themselves, are liable.

C. Relationships Between Certain Physical Defects and School Achievement:

In addition to their primary use in determining changes in achievement following the removal of certain physical defects, the data also afforded an opportunity to observe relationships between the presence or absence of certain physical defects and school achievement.

Pupils with the physical defects used in this study, namely, defective vision (15–30 or less), diseased tonsils, nasal obstruction, and dental caries, were found to have made lower test scores in arithmetic and reading than non-defective pupils. In

the light of the low coefficients of correlation, however, given in Table 15, p. 61, between the presence or absence of these physical defects and achievement in arithmetic and reading, and the probable errors of these coefficients, it is unlikely that there was either a very marked positive or negative association between these factors. The close correspondence of these results with other studies of similar relationships has been noted in the previous chapter, page 63.

D. Changes in Achievement Following the Removal of Certain Physical Defects:

1. *Defective Vision (15–30 or less):*

A positive relationship was revealed between the correction of defective vision and growth in achievement in arithmetic, reading, and spelling. In the light of the low coefficients of correlation, as given in Tables 18, 20, 22, pages 68, 70, 72, respectively, and the probable errors of these coefficients, however, it must be concluded that, after an average period of six to nine months between the correction of the defect and the final tests, it is unlikely that there was either a strong positive or negative association between the correction or non-correction of defective vision and growth in achievement in arithmetic, reading, and spelling, as measured by the tests used in this study.

The correction or non-correction of defective vision seemed to have had no marked positive or negative associations with changes in end-of-term records of conduct, effort, "present standing" (general average), or the number of end-of-term "crosses" (unsatisfactory subject ratings) in arithmetic, reading, and spelling, as recorded by teachers upon pupils' report cards. (See Tables 23, 24, 25, 26, pages 74, 75, 76, 77, respectively.)

The correction or non-correction of defective vision had no apparent influence upon absence for illness, or total absence. (See Tables 27 and 28, pages 78 and 79, respectively.)

2. *Hypertrophied, or Diseased, Tonsils:*

A negative association was obtained between the removal of hypertrophied, or diseased, tonsils and growth in achievement

in arithmetic, reading, and spelling. In the light of the low coefficients of correlation, as given in Tables 18, 20, 22, pages 68, 70, 72, respectively, and the probable errors of these coefficients, however, it must be concluded that, after an average period of seven to ten months between the correction of the defect and the final tests, it is unlikely that there was either a strong positive or negative association between the correction or non-correction of hypertrophied, or diseased, tonsils, and achievement in arithmetic, reading and spelling, as measured by the tests used in this study.

The correction or non-correction of diseased tonsils seemed to have had no marked positive or negative association with changes in end-of-term records of conduct, effort, present standing, (general average) and number of end-of-term "crosses" (unsatisfactory subject marks) in arithmetic, reading, and spelling as recorded by teachers upon pupils' report cards. (See Tables 23, 24, 25, 26, pages 74, 75, 76, 77 respectively.)

From the attendance records obtained for 1928–29, the school year preceding this study, pupils with diseased tonsils were absent from school for illness, and for all other causes more than pupils in the non-defective group. From the greater percentage of absence in the corrected group than in the uncorrected group in 1929–30, the school year during which the defects were corrected, it may be concluded that, after an average period of seven to ten months between the correction of the defect and the final records, there may have been a negative association between the removal of the diseased tonsils and school attendance. (See Tables 27, 28, pages 78, 79, respectively.)

3. *Nasal Obstruction:*

A very slight positive association was obtained between the removal of nasal obstruction and growth in achievement in arithmetic. A somewhat higher positive relationship was found between the removal of nasal obstruction and growth in achievement in spelling. A negative association was obtained between the removal of nasal obstruction and growth in arithmetic and reading, combined. In the light of the low coefficients of correlation, however, as given in Tables 18, 20, 22, pages 68, 70, 72

respectively, and the probable errors of these coefficients, it must be concluded that, after an average period of six to nine months between the correction of the defect and the final tests, it is unlikely that there was either a marked positive or negative association between the removal of nasal obstruction and growth in achievement in arithmetic, reading, and spelling, as measured by the tests used in this study.

The correction or non-correction of nasal obstruction seemed to have had no marked positive or negative associations with changes in end-of-term records of conduct, effort, present standing (general average), and the number of end-of-term "crosses" (unsatisfactory subject marks) in arithmetic, reading, and spelling, as recorded by teachers on pupils' report cards. (See Tables 23, 24, 25, 26, pages 74, 75, 76, 77 respectively.)

In connection with absences from school, the removal of nasal obstruction tended to decrease absences for illness more than the non-correction of the defect. On the other hand, the total absence of the corrected group was found to have been greater than that for the uncorrected group, for reasons which may or may not have had any association with the correction or non-correction of the defect. (See Tables 27, 28, pages 78, 79, respectively.)

4. *Dental Caries:*

A slight positive association was obtained between the correction of one to three defective teeth and gains in achievement in arithmetic and reading. This was offset, or neutralized, somewhat by a slight negative relationship between these factors when four or more decayed teeth were corrected. Thus, in the light of the low coefficients of correlation, as given in Table 22, page 72, and the probable errors of these coefficients, it must be concluded that, after an average period of time equal to eight months between the correction of the defect and the final tests, it is very unlikely that there was either a consistently positive, or negative, association between the correction or non-correction of dental caries, regardless of the number of decayed teeth, and growth in achievement in arithmetic and reading, as measured by the tests used in this study.

The correction or non-correction of dental caries likewise seemed to have had no marked associations with gains or losses in end-of-term records of conduct, effort, present standing (general average), or end-of-term "crosses" (unsatisfactory subject marks) in arithmetic and reading as recorded by teachers on pupils' report cards. (See Tables 23, 24, 25, 26, pages 74, 75, 76, 77, respectively.)

In regard to absences in 1928–29, there were no significant differences between the pupils with or without dental caries. In 1929–30, the school year in which the corrections were obtained, pupils in the corrected groups, regardless of the number of decayed teeth, were absent less than those in the uncorrected groups, suggesting that a part of this decrease may have been associated with the elimination of toothache as a cause for absence for illness. (See Tables 27, 28, pages 78, 79, respectively.)

E. General Conclusions:

In connection with specific defects, the following general tendencies may be noted:

1. The correction of defective vision (15–30 or less), appeared to have been associated positively with increased growth in achievement in arithmetic fundamentals, reading, and spelling.

2. The removal of nasal obstruction appeared to have been associated positively with increased growth in achievement in spelling.

3. The removal of hypertrophied, or diseased, tonsils appeared to have been associated negatively with increased growth in achievement in arithmetic fundamentals, reading, and spelling.

When taken as a whole, however, the disclosed relationships were so uniformly small, that it seems justifiable to conclude, that, within the limits of this study, the correction, or non-correction, of defective vision (15–30 or less), diseased tonsils, nasal obstruction, and dental caries (regardless of the number of decayed teeth), was not followed by any marked changes in arithmetic fundamentals, reading, and spelling.

F. Suggestions for Further Studies:

1. Changes in school achievement following the correction or

non-correction of defective vision, diseased tonsils, nasal obstruction, and dental caries, with the type and degree of severity of the defect determined by specialists.

2. Changes in school achievement following the correction or non-correction of nutritional disturbances, including severe degrees of underweight and overweight.

3. A study of the changes in achievement following the removal of physical defects, carried on for several years by an organization with ample financial resources to handle the large number of records that would be necessary to offset the losses for absences at tests, transfers, and other reasons for school "mortality" over a period of years.

4. A study of changes in school achievement following the correction of dental caries, utilizing the X-ray if necessary, to determine the possibility of focal infection in connection with the decay of a tooth.

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APPENDICES

Appendix A

COEFFICIENTS OF PARTIAL CORRELATION

I. Relationships between the Presence or Absence of certain Physical Defects and Achievement.

The negative coefficients of partial correlation in lists A-E below indicate that the Defective Groups tended to make slightly lower scores than the Non-Defective Group.

A. Relationships between the Presence or Absence of Dental Caries (1–3 defective teeth) and Achievement in Arithmetic and Reading, with the Influence of Age and Intelligence partialed out.

COEFFICIENTS OF PARTIAL CORRELATION

	SECOND ORDER	FIRST ORDER	ZERO ORDER
Defective and Non-Defective Groups:	$r_{12 \cdot 34} = -.003$	$r_{12 \cdot 3} = -.03$ $r_{14 \cdot 3} = -.11$ $r_{24 \cdot 3} = -.30$	$r_{bis12} = -.03 \pm .027$ $r_{bis13} = -.01 \pm .027$ $r_{bis14} = -.09 \pm .027$ $r_{23} = -.15 \pm .021$ $r_{24} = .33 \pm .019$ $r_{34} = -.53 \pm .015$

B. Relationships between the Presence or Absence of Dental Caries (4 or more defective teeth) and Achievement in Arithmetic and Reading, with the Influence of Age and Intelligence partialed out.

COEFFICIENTS OF PARTIAL CORRELATION

	SECOND ORDER	FIRST ORDER	ZERO ORDER
Defective and Non-Defective Groups:	$r_{12 \cdot 34} = -.01$	$r_{12 \cdot 3} = -.04$ $r_{14 \cdot 3} = -.08$ $r_{24 \cdot 3} = -.34$	$r_{bis12} = -.03 \pm .032$ $r_{bis13} = -.08 \pm .033$ $r_{bis14} = -.03 \pm .032$ $r_{23} = -.17 \pm .025$ $r_{24} = .38 \pm .023$ $r_{34} = -.52 \pm .018$

C. Relationships between the Presence or Absence of Defective Vision (15-30 or less) and Achievement in Arithmetic and Reading, with the Influence of Age and Intelligence partialed out.

Coefficients of Partial Correlation

	SECOND ORDER	FIRST ORDER	ZERO ORDER
Defective and Non-Defective Groups:	$r_{12 \cdot 34} = -.07$	$r_{12 \cdot 3} = -.13$ $r_{14 \cdot 3} = -.17$ $r_{24 \cdot 3} = -.40$	$r_{bis12} = -.12 \pm .037$ $r_{bis13} = -.03 \pm .037$ $r_{bis14} = -.12 \pm .037$ $r_{23} = -.21 \pm .026$ $r_{24} = .54 \pm .019$ $r_{34} = -.56 \pm .019$

D. Relationships between the Presence or Absence of Hypertrophied, or Diseased Tonsils, and Achievement in Arithmetic and Reading with the Influence of Age and Intelligence partialed out.

Coefficients of Partial Correlation

	SECOND ORDER	FIRST ORDER	ZERO ORDER
Defective and Non-Defective Groups:	$r_{12 \cdot 34} = -.06$	$r_{12 \cdot 3} = -.05$ $r_{14 \cdot 3} = .01$ $r_{24 \cdot 3} = -.39$	$r_{bis12} = -.06 \pm .042$ $r_{bis13} = .06 \pm .042$ $r_{bis14} = -.03 \pm .042$ $r_{23} = -.19 \pm .028$ $r_{24} = .42 \pm .024$ $r_{34} = -.54 \pm .021$

E. Relationships between the Presence or Absence of Nasal Obstruction and Achievement in Arithmetic and Reading, with the Influence of Age and Intelligence partialed out.

Coefficients of Partial Correlation

	SECOND ORDER	FIRST ORDER	ZERO ORDER
Defective and Non-Defective Groups:	$r_{12 \cdot 34} = -.02$	$r_{12 \cdot 3} = -.04$ $r_{14 \cdot 3} = -.05$ $r_{24 \cdot 3} = -.54$	$r_{bis12} = -.05 \pm .045$ $r_{bis13} = -.01 \pm .045$ $r_{bis14} = .05 \pm .045$ $r_{23} = -.17 \pm .029$ $r_{24} = .39 \pm .025$ $r_{34} = -.49 \pm .023$

II. Coefficients of Partial Correlation between the Correction or Non-Correction of Certain Physical Defects and Achievement, with the Influence of Age and Intelligence partialed out.

A positive coefficient of partial correlation indicates that the first group named tended to make greater gains in achievement than the other group with which it was paired. A negative coefficient of partial correlation indicates that the second group named tended to make greater gains in achievement than the other group with which it was paired.

A. Coefficients of Partial Correlation between the Correction or Non-Correction of Defective Vision and Gains or Losses in Arithmetic, June 1929–June 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, or No Defect
2. Gains or Losses in Arithmetic
3. Age
4. Intelligence

Coefficients of Partial Correlation

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12 \cdot 34} = .04$	$r_{12 \cdot 3} = .04$ $r_{14 \cdot 3} = -.01$ $r_{24 \cdot 3} = .13$	$r_{bis12} = .07 \pm .060$ $r_{bis13} = -.21 \pm .058$ $r_{bis14} = .12 \pm .060$ $r_{23} = -.18 \pm .046$ $r_{24} = .21 \pm .046$ $r_{34} = -.61 \pm .030$
2. Corrected and No-Defect Groups:	$r_{12 \cdot 34} = .02$	$r_{12 \cdot 3} = .02$ $r_{14 \cdot 3} = -.09$ $r_{24 \cdot 3} = .06$	$r_{bis12} = .02 \pm .036$ $r_{bis13} = -.04 \pm .036$ $r_{bis14} = -.06 \pm .036$ $r_{23} = -.13 \pm .017$ $r_{24} = .11 \pm .017$ $r_{34} = -.46 \pm .014$
3. No-Defect and Uncorrected Groups:	$r_{12 \cdot 34} = .004$	$r_{12 \cdot 3} = .01$ $r_{14 \cdot 3} = .09$ $r_{24 \cdot 3} = .03$	$r_{bis12} = .02 \pm .032$ $r_{bis13} = -.15 \pm .033$ $r_{bis14} = .15 \pm .032$ $r_{23} = -.07 \pm .017$ $r_{24} = .06 \pm .017$ $r_{34} = -.46 \pm .013$

B. Coefficients of Partial Correlation between the Correction or Non-Correction of Diseased Tonsils and Gains or Losses in Arithmetic, June, 1929–June 1930, with the Influence of Age and Intelligence partialed out.

Variables:
1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic
3 Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = -.19$	$r_{12\cdot3} = -.17$ $r_{14\cdot3} = .12$ $r_{24\cdot3} = .15$	$r_{bis12} = -.18 \pm .077$ $r_{bis13} = -.14 \pm .078$ $r_{bis14} = .16 \pm .077$ $r_{23} = -.11 \pm .062$ $r_{24} = .17 \pm .061$ $r_{34} = -.35 \pm .055$
2. Corrected and No-Defect Groups:	$r_{12\cdot34} = -.03$	$r_{12\cdot3} = -.03$ $r_{14\cdot3} = -.03$ $r_{24\cdot3} = .06$	$r_{bis1.} = -.03 \pm .022$ $r_{bis1.} = -.05 \pm .022$ $r_{bis4} = -.002 \pm .022$ $r_{23} = -.13 \pm .017$ $r_{24} = .11 \pm .017$ $r_{34} = -.45 \pm .014$
3. No-Defect and Uncorrected Groups:	$r_{12\cdot34} = -.12$	$r_{12\cdot3} = -.11$ $r_{14\cdot3} = .10$ $r_{24\cdot3} = .05$	$r_{bis12} = -.11 \pm .004$ $r_{bis13} = -.03 \pm .004$ $r_{bis14} = .11 \pm .004$ $r_{23} = -.12 \pm .017$ $r_{24} = .10 \pm .017$ $r_{34} = -.45 \pm .014$

C. Coefficients of Partial Correlation between the Correction or Non-Correction of Nasal Obstruction and Gains or Losses in Arithmetic, June, 1929–June, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = .02$	$r_{12\cdot3} = .03$ $r_{14\cdot3} = .13$ $r_{24\cdot3} = .08$	$r_{bis12} = .02 \pm .096$ $r_{bis13} = .21 \pm .093$ $r_{bis14} = .01 \pm .096$ $r_{23} = -.02 \pm .069$ $r_{24} = .08 \pm .069$ $r_{34} = -.50 \pm .052$
2. Corrected and No-Defect Groups:	$r_{12\cdot34} = .07$	$r_{12\cdot3} = .07$ $r_{14\cdot3} = .05$ $r_{24\cdot3} = .05$	$r_{bis12} = .05 \pm .006$ $r_{bis13} = .13 \pm .005$ $r_{bis14} = -.01 \pm .006$ $r_{23} = -.12 \pm .017$ $r_{24} = .10 \pm .018$ $r_{34} = -.46 \pm .014$
3. No-Defect and Uncorrected Groups:	$r_{12\cdot34} = -.04$	$r_{12\cdot3} = -.04$ $r_{14\cdot3} = .03$ $r_{24\cdot3} = .02$	$r_{bis12} = -.04 \pm .004$ $r_{bis13} = .02 \pm .004$ $r_{bis14} = .02 \pm .004$ $r_{23} = -.13 \pm .017$ $r_{24} = .08 \pm .017$ $r_{34} = -.48 \pm .013$

D. Coefficients of Partial Correlation between the Correction or Non-Correction of Defective Vision and Gains and Losses in Spelling, Sept., 1929–June, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Spelling
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = -.03$	$r_{12\cdot3} = -.03$ $r_{14\cdot3} = -.02$ $r_{24\cdot3} = -.03$	$r_{bis12} = -.05 \pm .062$ $r_{bis13} = -.22 \pm .060$ $r_{bis14} = .12 \pm .062$ $r_{23} = .06 \pm .049$ $r_{24} = -.06 \pm .049$ $r_{34} = -.61 \pm .031$
2. Corrected and No-Defect Groups:	$r_{12\cdot34} = -.03$	$r_{12\cdot3} = -.03$ $r_{14\cdot3} = -.08$ $r_{24\cdot3} = .02$	$r_{bis12} = -.03 \pm .038$ $r_{bis13} = -.04 \pm .038$ $r_{bis14} = -.05 \pm .038$ $r_{23} = -.03 \pm .018$ $r_{24} = .03 \pm .018$ $r_{34} = -.46 \pm .014$
3. No-Defect and Uncorrected Groups:	$r_{12\cdot34} = -.004$	$r_{12\cdot3} = -.003$ $r_{14\cdot3} = .09$ $r_{24\cdot3} = .08$	$r_{bis12} = -.01 \pm .032$ $r_{bis13} = -.15 \pm .031$ $r_{bis14} = .15 \pm .031$ $r_{23} = .06 \pm .017$ $r_{24} = .07 \pm .017$ $r_{34} = -.46 \pm .013$

E. Coefficients of Partial Correlation between the Correction or Non-Correction of Diseased Tonsils and Gains or Losses in Spelling, September 1929–June, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Spelling
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION
(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = -.03$	$r_{12\cdot3} = -.05$ $r_{14\cdot3} = -.12$ $r_{24\cdot3} = .18$	$r_{bis12} = -.06 \pm .087$ $r_{bis13} = -.04 \pm .087$ $r_{bis14} = .13 \pm .086$ $r_{23} = -.04 \pm .063$ $r_{24} = .15 \pm .062$ $r_{34} = -.45 \pm .052$
2. Corrected and No-Defect Groups:	$r_{12\cdot34} = -.03$	$r_{12\cdot3} = -.03$ $r_{14\cdot3} = .01$ $r_{24\cdot3} = .04$	$r_{bis12} = -.03 \pm .047$ $r_{bis13} = .05 \pm .046$ $r_{bis14} = -.02 \pm .047$ $r_{23} = -.04 \pm .045$ $r_{24} = .05 \pm .045$ $r_{34} = -.45 \pm .036$
3. No-Defect and Uncorrected Groups:	$r_{12\cdot34} = .002$	$r_{12\cdot3} = .004$ $r_{14\cdot3} = .05$ $r_{24\cdot3} = .03$	$r_{bis12} = .01 \pm .004$ $r_{bis13} = -.13 \pm .004$ $r_{bis14} = .11 \pm .004$ $r_{23} = -.03 \pm .017$ $r_{24} = .04 \pm .017$ $r_{34} = -.45 \pm .017$

F. Coefficients of Partial Correlation between the Correction or Non-Correction of Nasal Obstruction and Gains or Losses in Spelling, September, 1929–June, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Spelling
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12 \cdot 34} = .23$	$r_{12 \cdot 3} = .23$ $r_{14 \cdot 3} = -.10$ $r_{24 \cdot 3} = .003$	$r_{bis12} = .22 \pm .098$ $r_{bis13} = .22 \pm .098$ $r_{bis14} = .03 \pm .101$ $r_{23} = -.22 \pm .067$ $r_{24} = .11 \pm .070$ $r_{34} = -.50 \pm .053$
2. Corrected and No-Defect Groups:	$r_{12 \cdot 34} = .29$	$r_{12 \cdot 3} = .29$ $r_{14 \cdot 3} = .05$ $r_{24 \cdot 3} = .03$	$r_{bis12} = .28 \pm .024$ $r_{bis13} = .21 \pm .025$ $r_{bis14} = -.05 \pm .025$ $r_{23} = -.04 \pm .018$ $r_{24} = .04 \pm .018$ $r_{34} = -.46 \pm .014$
3. No-Defect and Uncorrected Groups:	$r_{12 \cdot 34} = -.04$	$r_{12 \cdot 3} = -.04$ $r_{14 \cdot 3} = .11$ $r_{24 \cdot 3} = -.001$	$r_{bis12} = -.05 \pm .004$ $r_{bis13} = .15 \pm .003$ $r_{bis14} = .02 \pm .004$ $r_{23} = -.05 \pm .017$ $r_{24} = .02 \pm .017$ $r_{34} = -.48 \pm .013$

G. Coefficients of Partial Correlation between the Correction or Non-Correction of Dental Caries (1–3 defective teeth) and Gains or Losses in Arithmetic and Reading, June, 1929–September, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic and Reading
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12 \cdot 34} = .09$	$r_{12 \cdot 3} = .07$ $r_{14 \cdot 3} = -.13$ $r_{24 \cdot 3} = .13$	$r_{bis12} = .09 \pm .046$ $r_{bis13} = -.17 \pm .045$ $r_{bis14} = -.04 \pm .046$ $r_{23} = -.15 \pm .032$ $r_{24} = .19 \pm .032$ $r_{34} = -.46 \pm .026$
2. Corrected and No-Defect Groups:	$r_{12 \cdot 34} = .12$	$r_{12 \cdot 3} = .11$ $r_{14 \cdot 3} = -.14$ $r_{24 \cdot 3} = .06$	$r_{bis12} = .11 \pm .043$ $r_{bis13} = -.12 \pm .043$ $r_{bis14} = -.06 \pm .043$ $r_{23} = -.04 \pm .031$ $r_{24} = .07 \pm .030$ $r_{34} = -.51 \pm .031$
3. No-Defect and Uncorrected Groups:	$r_{12 \cdot 34} = -.03$	$r_{12 \cdot 3} = -.02$ $r_{14 \cdot 3} = -.01$ $r_{24 \cdot 3} = .10$	$r_{bis12} = -.02 \pm .032$ $r_{bis13} = -.05 \pm .032$ $r_{bis14} = .03 \pm .032$ $r_{23} = -.06 \pm .026$ $r_{24} = .11 \pm .025$ $r_{34} = -.49 \pm .020$

H. Coefficients of Partial Correlation between the Correction or Non-Correction of Dental Caries (4 or more decayed teeth) and Gains or Losses in Arithmetic and Reading, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic and Reading
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = -.13$	$r_{12\cdot3} = -.14$ $r_{14\cdot3} = .07$ $r_{24\cdot3} = .10$	$r_{bis12} = -.14 \pm .057$ $r_{bis13} = -.06 \pm .058$ $r_{bis14} = .09 \pm .058$ $r_{23} = -.06 \pm .046$ $r_{24} = .11 \pm .046$ $r_{34} = -.55 \pm .032$
2. Corrected and No Defect Groups:	$r_{12\cdot34} = .01$	$r_{12\cdot3} = .01$ $r_{14\cdot3} = .01$ $r_{24\cdot3} = .11$	$r_{bis12} = .01 \pm .045$ $r_{bis13} = -.05 \pm .045$ $r_{bis14} = .04 \pm .045$ $r_{23} = -.03 \pm .032$ $r_{24} = .11 \pm .032$ $r_{34} = -.48 \pm .025$
3. No Defect and Uncorrected Groups:	$r_{12\cdot34} = -.16$	$r_{12\cdot3} = -.16$ $r_{14\cdot3} = .06$ $r_{24\cdot3} = .05$	$r_{bis12} = -.16 \pm .041$ $r_{bis13} = -.001 \pm .042$ $r_{bis14} = .05 \pm .042$ $r_{23} = .004 \pm .031$ $r_{24} = .05 \pm .030$ $r_{34} = -.52 \pm .022$

I. Coefficients of Partial Correlation between the Correction or Non-Correction of Defective Vision and Gains or Losses in Arithmetic and Reading, June, 1929–September, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic and Reading
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12 \cdot 34} = .18$	$r_{12 \cdot 3} = .17$ $r_{14 \cdot 3} = .003$ $r_{24 \cdot 3} = .27$	$r_{bis12} = .18 \pm .069$ $r_{bis13} = -.21 \pm .068$ $r_{bis14} = .12 \pm .070$ $r_{23} = -.07 \pm .056$ $r_{24} = .26 \pm .052$ $r_{34} = -.56 \pm .038$
2. Corrected and No-Defect Groups:	$r_{12 \cdot 34} = .04$	$r_{12 \cdot 3} = .02$ $r_{14 \cdot 3} = -.10$ $r_{24 \cdot 3} = .13$	$r_{bis12} = .03 \pm .040$ $r_{bis13} = -.07 \pm .040$ $r_{bis14} = -.06 \pm .040$ $r_{23} = -.08 \pm .020$ $r_{24} = .15 \pm .020$ $r_{34} = -.49 \pm .015$
3. No-Defect and Uncorrected Groups:	$r_{12 \cdot 34} = .10$	$r_{12 \cdot 3} = .11$ $r_{14 \cdot 3} = .11$ $r_{24 \cdot 3} = .13$	$r_{bis12} = .12 \pm .038$ $r_{bis13} = -.10 \pm .038$ $r_{bis14} = .14 \pm .038$ $r_{23} = -.08 \pm .020$ $r_{24} = .15 \pm .019$ $r_{34} = -.49 \pm .015$

J. Coefficients of Partial Correlation between the Correction or Non-Correction of Diseased Tonsils and Gains or Losses in Arithmetic, June, 1929–September, 1930, with the Influence of Age and Intelligence partialed out.

Variables:
1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic and Reading
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = -.12$	$r_{12\cdot3} = -.12$ $r_{14\cdot3} = .14$ $r_{24\cdot3} = .002$	$r_{bis12} = -.09 \pm .085$ $r_{bis13} = -.30 \pm .080$ $r_{bis14} = .13 \pm .085$ $r_{23} = -.09 \pm .068$ $r_{24} = .04 \pm .068$ $r_{34} = -.45 \pm .055$
2. Corrected and No-Defect Groups:	$r_{12\cdot34} = .01$	$r_{12\cdot3} = .002$ $r_{14\cdot3} = -.01$ $r_{24\cdot3} = .21$	$r_{bis12} = -.004 \pm .005$ $r_{bis13} = -.07 \pm .004$ $r_{bis14} = .02 \pm .005$ $r_{23} = .08 \pm .020$ $r_{24} = .02 \pm .020$ $r_{34} = -.50 \pm .015$
3. No-Defect and Uncorrected Groups:	$r_{12\cdot34} = -.08$	$r_{12\cdot3} = -.08$ $r_{14\cdot3} = .001$ $r_{24\cdot3} = .09$	$r_{bis12} = -.07 \pm .004$ $r_{bis13} = -.14 \pm .004$ $r_{bis14} = .07 \pm .004$ $r_{23} = -.08 \pm .020$ $r_{24} = .12 \pm .020$ $r_{34} = -.49 \pm .015$

K. Coefficients of Partial Correlation between the Correction or Non-Correction of Nasal Obstruction and Gains or Losses in Arithmetic and Reading, June, 1929–September, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defect
2. Gains or Losses in Arithmetic and Reading
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12\cdot34} = -.05$	$r_{12\cdot3} = .01$ $r_{14\cdot3} = .66$ $r_{24\cdot3} = .08$	$r_{bis12} = .02 \pm .112$ $r_{bis13} = .17 \pm .110$ $r_{bis14} = .50 \pm .094$ $r_{23} = .07 \pm .078$ $r_{24} = .03 \pm .078$ $r_{34} = -.49 \pm .060$
2. Corrected and No-Defect Groups:	$r_{12\cdot34} = -.03$	$r_{12\cdot3} = -.03$ $r_{14\cdot3} = .001$ $r_{24\cdot3} = .11$	$r_{bis12} = -.02 \pm .006$ $r_{bis13} = -.09 \pm .006$ $r_{bis14} = .05 \pm .006$ $r_{23} = -.08 \pm .020$ $r_{24} = .13 \pm .020$ $r_{34} = -.50 \pm .015$
3. No-Defect and Uncorrected Groups:	$r_{12\cdot34} = .02$	$r_{12\cdot3} = .05$ $r_{14\cdot3} = .37$ $r_{24\cdot3} = .08$	$r_{bis12} = .05 \pm .041$ $r_{bis13} = .01 \pm .041$ $r_{bis14} = .31 \pm .039$ $r_{23} = -.08 \pm .020$ $r_{24} = .11 \pm .020$ $r_{34} = -.52 \pm .015$

L. Coefficients of Partial Correlation between the Correction or Non-Correction of Diseased Tonsils and Nasal Obstruction and Gains or Losses in Arithmetic and Reading, June, 1929–September, 1930, with the Influence of Age and Intelligence partialed out.

Variables:

1. Defect Groups—Corrected, Uncorrected, No Defects
2. Gains or Losses in Arithmetic and Reading
3. Age
4. Intelligence

COEFFICIENTS OF PARTIAL CORRELATION

(See page 109 for interpretation of positive and negative coefficients)

	SECOND ORDER	FIRST ORDER	ZERO ORDER
1. Corrected and Uncorrected Groups:	$r_{12 \cdot 34} = -.02$	$r_{12 \cdot 3} = -.02$ $r_{14 \cdot 3} = .05$ $r_{24 \cdot 3} = .05$	$r_{bis12} = -.02 \pm .066$ $r_{bis13} = -.12 \pm .065$ $r_{bis14} = .09 \pm .066$ $r_{23} = .02 \pm .052$ $r_{24} = .03 \pm .051$ $r_{34} = -.47 \pm .040$
2. Corrected and No-Defect Groups:	$r_{12 \cdot 34} = -.02$	$r_{12 \cdot 3} = -.01$ $r_{14 \cdot 3} = .02$ $r_{24 \cdot 3} = .11$	$r_{bis12} = -.01 \pm .041$ $r_{bis13} = -.03 \pm .041$ $r_{bis14} = .03 \pm .041$ $r_{23} = -.09 \pm .020$ $r_{24} = .14 \pm .020$ $r_{34} = -.50 \pm .015$
3. No-Defect and Uncorrected Groups:	$r_{12 \cdot 34} = -.01$	$r_{12 \cdot 3} = -.01$ $r_{14 \cdot 3} = .01$ $r_{24 \cdot 3} = .16$	$r_{bis12} = -.01 \pm .034$ $r_{bis13} = -.06 \pm .034$ $r_{bis14} = .04 \pm .034$ $r_{23} = .07 \pm .020$ $r_{24} = .11 \pm .020$ $r_{34} = -.50 \pm .014$

Appendix B

SPECIMEN EXAMPLES FROM THE ARITHMETIC TESTS USED IN THIS STUDY

Grade 2B* End-of-Term Sub-Tests

	I	II	III	IV
NO. OF EXAMPLES	100	144	64	44
OPERATION	ADD	SUBTRACT	MULTIPLY	DIVIDE
	9 4	10 3	5 4	6) 12

* In the Philadelphia Public Schools the "B" grade section represents the second semester of the school year.

Grade 3A—End-of-Term Sub-Tests

	I	II	III	IV
NO. OF EXAMPLES	24	24	16	16
OPERATION	ADD	SUBTRACT	MULTIPLY	DIVIDE
	65 15	31 13	365 3	2) 72

Grade 3B—End-of-Term Sub-Tests

	I	II	III	IV
NO. OF EXAMPLES	15	15	16	16
OPERATION	ADD	SUBTRACT	MULTIPLY	DIVIDE
	457 232 164	727 428	486 3	4) 128

GRADE 4A—END-OF-TERM SUB TESTS

	I	II	III	IV
NO. OF EXAMPLES	15	15	12	12
OPERATION	ADD	SUBTRACT	MULTIPLY	DIVIDE
	4351 1202 8755 5305	5823 2487	247 53	21) 885

GRADE 4B—END-OF-TERM SUB-TESTS

	I	II	III	IV
NO. OF EXAMPLES	15	15	12	12
OPERATION	ADD	SUBTRACT	MULTIPLY	DIVIDE
	706 159 623 847 204	80767 79839	137 346	127) 19558

GRADE 5A—END-OF-TERM SUB-TESTS

	I	II	III	IV	V	VI
NO. OF EXAMPLES	15	15	12	9	15	15
OPERATION	ADD	SUB-TRACT	MULTI-PLY	DIVIDE	ADD	SUBTRACT
	46895 37584 89602 54169 68297	80767 79839	137 346	455) 148785	$\frac{1}{2}$ $\frac{3}{4}$	$\frac{3}{4}$ $\frac{1}{2}$

GRADE 5B—END-OF-TERM SUB-TESTS

	I	II	III	IV	V	VI
NO. OF EXAMPLES	15	15	12	9	15	15
OPERATION	ADD	SUB-TRACT	MULTI-PLY	DIVIDE	ADD	SUBTRACT
	46895 37584 89602 54169 68297	80767 79839	137 346	455) 148785	$4\frac{1}{2}$ $3\frac{1}{3}$	$6\frac{1}{2}$ $4\frac{2}{3}$
	VII	VIII				
NO. OF EXAMPLES	15	15				
OPERATION	MULTIPLY $\frac{1}{2} \times \frac{3}{4}$	DIVIDE $\frac{1}{2} \div \frac{3}{4}$				

GRADE 6A—END-OF-TERM SUB-TESTS

	I	II	III	IV	V	VI
NO. OF EXAMPLES	6	6	9	6	6	9
OPERATION	ADD	SUB-TRACT	MULTI-PLY	DIVIDE	ADD	SUBTRACT
	Add .743 .8207 .35	Sub. 41.307 from 65.8	.32 .46	17) 20.74	$2\frac{5}{8}$ 3 5 3/8	24 $5\frac{1}{4}$
	VII DECIMAL-FRACTION EQUIVALENTS					
	(12 examples) $\frac{1}{2}$ = 3/5 = 3/10 =	(12 examples) .5 = .125 = .75 =				

APPENDIX C

Description of Record Sheet Used in this Study

A. General Plan of Record Sheet Used in this Study. Size of Sheet, 21x32 Inches

RECORD SHEET

.....School
.....Grade—Sept., 1929
.....Room No.—Sept., 1929
.....Teacher—Sept., 1929

Study of Changes in Achievement Following the Removal of Certain Physical Defects in Elementary School Pupils

Raymond L. Chambers

F. S. Key Public School, 8th and Wolf Sts., Phila., Pa.

1929–1930

School.....
Grade—Sept., 1929.....
Room No. Sept., 1929.....
Teacher—Sept., 1929.....

I	II	III	IV	V	VI	VII	VIII	IX
NO.	IDENTIFICATION DATA	AGE AND INTELLIGENCE RECORDS	ACHIEVEMENT TEST RESULTS	REMARKS	NO.	PUPILS' NAMES	ROUTINE MEDICAL EXAMINATION DATA	ATTENDANCE DATA AND TEACHERS' MARKS
	See page 126 for list of items included under this section of Record Sheet	See page 126 for list of items included under this section of Record Sheet	See pages 126–28 for list of items included under this section of Record Sheet	See pages 128 for list of items included under this section of Record Sheet	See page 128	See page 128	See pages 128–29 for list of items included under this section of Record Sheet	See pages 130–31 for list of items included under this section of Record Sheet
COL. 1	COLUMNS 2–11	COLUMNS 12–19	COLUMNS 20–44	COLUMNS 45–50	COL. 51	COL. 52	COLUMNS 53–79	COLUMNS 80–115

See opposite page for balance of Record Sheet

See opposite page for upper part of Record Sheet

1					1				
2					2				
59					59				
60					60				

DIRECTIONS FOR RECORDING:

Column 7: Use "W" for White; "N" for Negro; "M" for Mongolian.

Columns 8, 9: Indicate by Initial Letters or first two letters as follows:

A. Austria	E. England	Ir. Ireland	R. Russia	U. United States
C. Canada	G. Germany	L. Lithuania	Ru. Rumania	
CS. Czecho-Slovakia	H. Hungary	N. Norway	S. Scotland	
D. Denmark	I. Italy	P. Poland	Sw. Sweden	

Column 10: If pupil enters public school above grade 1A, indicate date of entrance.

Column 18: H: Haggerty; O: Otis.

APPENDIX C (*Continued*)

B. Lists of Items Included Under Sections I–IX of Record Sheet

Section I, Number:

Column 1. Numbers (1–60) on horizontal lines ruled on Record Sheet.

Section II, Identification Data:

(From Registration Card, Forms E 1, E2, Phila. Public Schools.)

Column 2. Pupils' Names.
3. Grade, June, 1929, before promotion.
4. Grade, February, 1930, after promotion.
5. Room Number, June, 1929, before promotion.
6. Room Number, February, 1930, after promotion.
7. Race.
8. Country of Birth, Child.
9. Country of Birth, Father.
10. Date of Entrance to Grade 1A.
11. Number of Different Schools Attended.

Section III, Age and Intelligence Records:

(From Registration Card, Forms E1, E2, and Achievement Record Card, Form R 400, Phila. Public Schools.)

Column 12. Chronological Age—Years.
13. Chronological Age—Months.
14. Deviations, in Months, above or below median age for grade.
15. Deviations above or below median age for grade translated into positive quantities by the addition of 30 algebraically to all deviations recorded in column 14, in order to facilitate their use on the Hollerith Printing Tabulator.
16. Intelligence Quotients.
17. Intelligence Quotients in column 16 divided by 5 in order to facilitate their use on the Hollerith Printing Tabulator.
18. Names of Intelligence Tests.
19. Date Intelligence Tests were given.

Section IV, Achievement Test Results:

(From Pupils' Test Papers)

A. Arithmetic Tests:

Column 20. Raw Scores, Phila. Survey Test, June, 1929.
21. Standard Scores, Phila. Survey Test, June, 1929.
22. Raw Scores, Phila. Survey Test, June, 1930.

23. Standard Scores, Phila. Survey Test, June, 1930.
24. Gains or Losses in Standard Scores, June, 1929-June, 1930.
25. Gains and Losses (column 24) translated into positive values by adding 10 algebraically to the gains or losses in column 24, in order to facilitate their use on the Hollerith Printing Tabulator.
26. Raw Scores in Phila. Survey and Diagnostic Test, Sept., 1930.
27. Standard Scores, Phila. Survey and Diagnostic Test, September, 1930.
28. Gains or Losses in Standard Scores, June, 1929–September, 1930.
29. Gains or Losses in Standard Scores (column 28), translated into positive quantities by adding 10 algebraically to the values recorded in column 28 in order to facilitate their use on the Hollerith Printing Tabulator.

B. Reading Tests:

Column 30. Raw Scores, Stanford Paragraph-Meaning Test, June, 1929.
31. Standard Scores, Stanford Paragraph-Meaning Test, June, 1929.
32. Raw Scores, Stanford Paragraph-Meaning Test, September, 1930.
33. Standard Scores, Stanford Paragraph-Meaning Test, September, 1930.
34. Gains or Losses in Standard Scores, June, 1929–September, 1930.
35. Gains or Losses in Standard Scores (column 34), translated into positive quantities by adding 10 algebraically to all values recorded in column 34 in order to facilitate their use on the Hollerith Printing Tabulator.
36. Gains or Losses in Standard Scores in Arithmetic Test (June 1929–September, 1930, column 28) and Reading Tests (June 1929–September, 1930, column 34) combined.
37. The combined Gains or Losses in standard scores in Arithmetic and Reading Tests, column 36, translated into positive quantities by adding 20 algebraically to all values recorded in column 36, in order to facilitate their use on the Hollerith Printing Tabulator.

C. Spelling Tests:

Column 38. Raw Scores, September, 1929.
39. Standard Scores, September, 1929.
40. Raw Scores, June, 1930.
41. Standard Scores, June, 1930.
42. Gains or Losses in Standard Scores, September, 1929-June, 1930.
43. Gains or Losses in Standard Scores, column 42, translated into positive quantities by adding 10 algebraically to all values recorded in column 42, in order to facilitate their use on the Hollerith Printing Tabulator.

D. Column 44. Sum of Standard Scores in Arithmetic Test, June, 1929 (column 21) and Reading Test, June, 1929 (column 31) combined.

Section V. Remarks:

Columns 45–50. "Remarks," for use as needed. Several of these columns were used for recording pupils' dates of birth and periodic changes of pupils from one ability group to another.

Section VI, Number:

Column 51. The numbers (1-60) on horizontal lines on Record Sheet as in Column 1.

Section VII, Pupils' Names:

Column 52. Pupils' Names, as in column 2. This repetition of numbers and names enabled the sheet to be used folded in halves.

Section VIII, Routine Medical Examination Data:

(From Routine Medical Examination Card, Forms MEH 3, MEH 4, Phila. Public Schools)

A. Column 53. Date of Medical Examination.

B. Records of Eye Defects:*

Column 54. Cases of 15-30 vision.
55. Cases of 15-50 and 15-70 vision.
56. Cases of less than 15-70 vision.
57. Date of Correction of Eye Defects.

C. Records of Nose and Throat Defects:*

Column 58. Cases of Hypertrophied or Diseased Tonsils.
59. Date of Correction of Tonsil defects.

60. Cases of Nasal Obstruction
61. Date of Correction of Nasal Obstruction.

D. Records of Teeth Defects:*

Column 62. Cases of 1–3 Decayed Teeth.
63. Cases of 4 or more Decayed Teeth.
64. Date of Correction of Teeth Defects.

E. Records of Nutritional Disturbances:

Column 65. Height at time of Routine Medical Examination.
66. Height at Second Weighing, September, 1930.
67. Weight at time of Routine Medical Examination.
68. Weight at Second Weighing, September, 1930.
69. Gain or Loss in Weight between First and Second Weighings (columns 67 and 68).
70. Standard Weight for Height at time of Routine Medical Examination.
71. Standard Weight for Height at time of Second Weighing, September, 1930.
72. Per Cent Under or Overweight at time of Routine Medical Examination.
73. Per Cent Under or Overweight at time of Second Weighing, September, 1930.
74. Number of Months between date of Routine Medical Examination and Second Weighing.

F. Records of Other Defects:

Column 75. Cases of Anemia.
76. Cases of Nervous Weakness.
77. Cases of Heart Defects.

G. Column 78. Code Numbers assigned to Defect Groups.

H. Column 79. Number of Months Elapsed between Date of Correction of Defect and Date of Final Test.

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* Cases of Eye and Nose and Throat Defects were recorded in columns 54, 55, 56, 58, 60, respectively, by writing in the number of successive years the defect had been noted by the medical examiner on the routine medical examination card.

Cases of Teeth Defects were recorded in columns 62, 63 by writing in the actual number of carious teeth noted by the medical examiner on the routine medical inspection card.

SECTION IX, ATTENDANCE DATA AND TEACHERS' MARKS:

(From Roll Book Leaf, Forms E71, E72, Phila. Public Schools)

A. Absence, Illness only:
Column 80. Term ending January, 1929.
81. Term ending June, 1929.
82. Term ending January, 1930.
83. Term ending, June, 1930.

B. Absence, Total:
Column 84. Term ending January, 1929.
85. Term ending June, 1929.
86. Term ending January, 1930.
87. Term ending June, 1930.

C. Conduct:
Column 88. Term ending January, 1929.
89. Term ending June, 1929.
90. Term ending January, 1930.
91. Term ending June, 1930.

D. Effort:
Column 92. Term ending January, 1929.
93. Term ending June, 1929.
94. Term ending January, 1930.
95. Term ending June, 1930.

E. Present Standing:
Column 96. Term ending January, 1929.
97. Term ending June, 1929.
98. Term ending January, 1930.
99. Term ending June, 1930.

F. Term Failures in Arithmetic:
Column 100. Term ending January, 1929.
101. Term ending June, 1929.
102. Term ending January, 1930.
103. Term ending June, 1930.

G. Term Failures in Written English:
Column 104. Term ending January, 1929.
105. Term ending June, 1929.
106. Term ending January, 1930.
107. Term ending June, 1930.

H. Term Failures in Reading:

Column 108. Term ending January, 1929.
109. Term ending June, 1929.
110. Term ending January, 1930.
111. Term ending June, 1930.

I. Term Failures in Spelling:

Column 112. Term ending January, 1929.
113. Term ending June, 1929.
114. Term ending January, 1930.
115. Term ending June, 1930.

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